

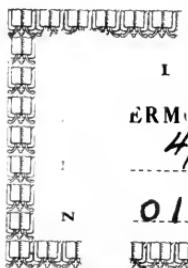
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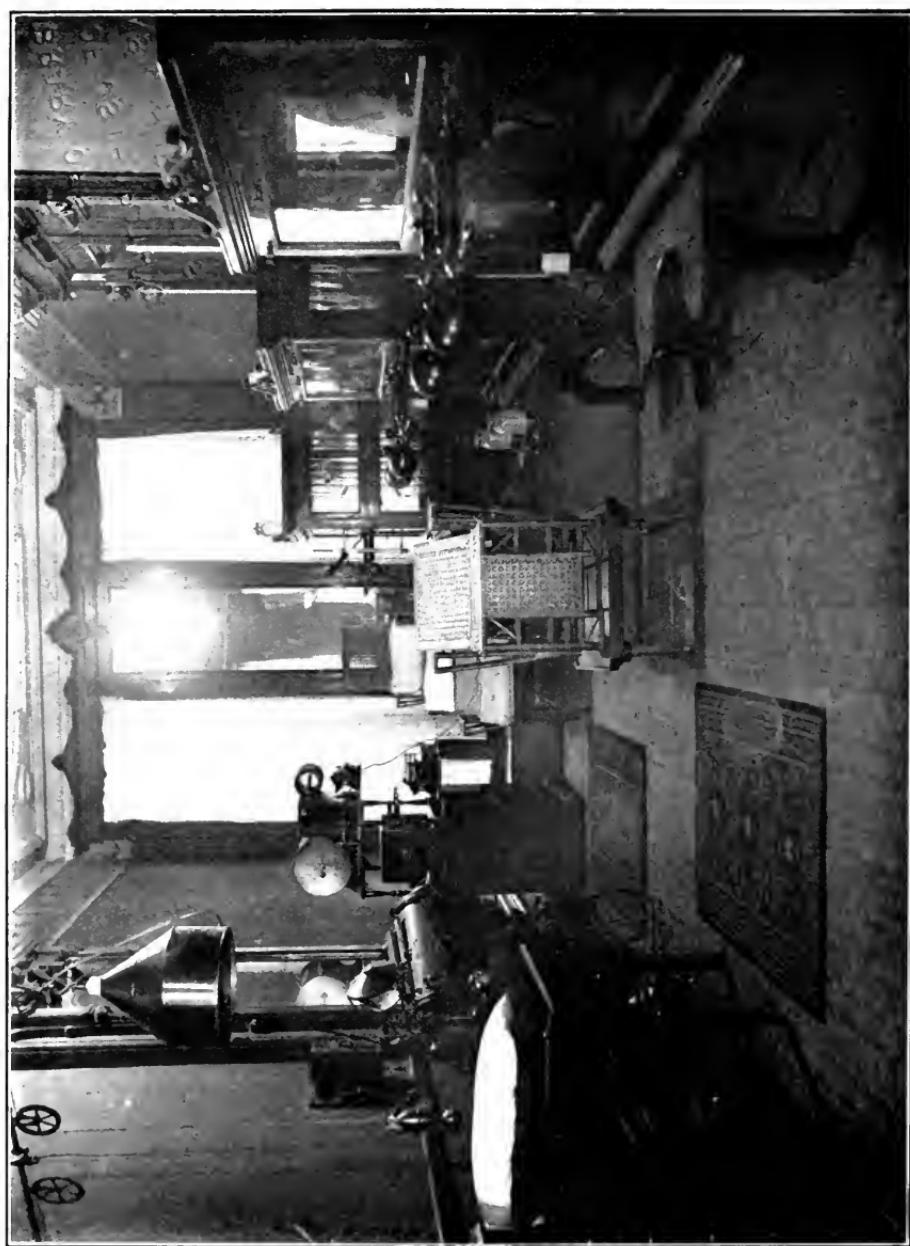


Plate I.—Author's and Associate's Largest Operating Room with Screens and Curtains Removed.

THE THERAPEUTICS *of* RADIANT LIGHT AND HEAT, AND CONVECTIVE HEAT

BY

WILLIAM BENHAM SNOW, M.D.

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WILLIAM BENHAM SNOW, M.D.

TO
MY MOTHER

*The noblest thoughts my soul can claim,
The holiest words my tongue can frame,
Unworthy are to praise the name
More sacred than all other.*

GEORGE GRIFFITH FETTER

PREFACE

AT the request of students and other members of the profession for a condensed manual on the employment of *radiant light and heat*, the writer has been induced to prepare the following chapters.

In considering the subject, attention has been devoted to the elucidation of the physiological actions, practical indications, and methods of employing radiant light and heat from the modern point of view.

It will be found by investigators that there is much to be derived from the scientific employment of these measures in therapeutics; and that the field of indication is much greater than the rank and file of the profession are aware of.

A chapter has been included on the relative action of radiant light and heat and the Roentgen ray, a subject of great importance in radiotherapy.

Four chapters have been added on the employment of convective heat, as showing the contrast and similarity of action from the employment of the two forms of heat—radiant and convective.

It has been the writer's purpose in the preparation of this little volume, as far as possible, to make it a practical aid to beginners in an important department of physical therapeutics, in which, if he has succeeded, he will be rewarded for his efforts.

WILLIAM BENHAM SNOW.

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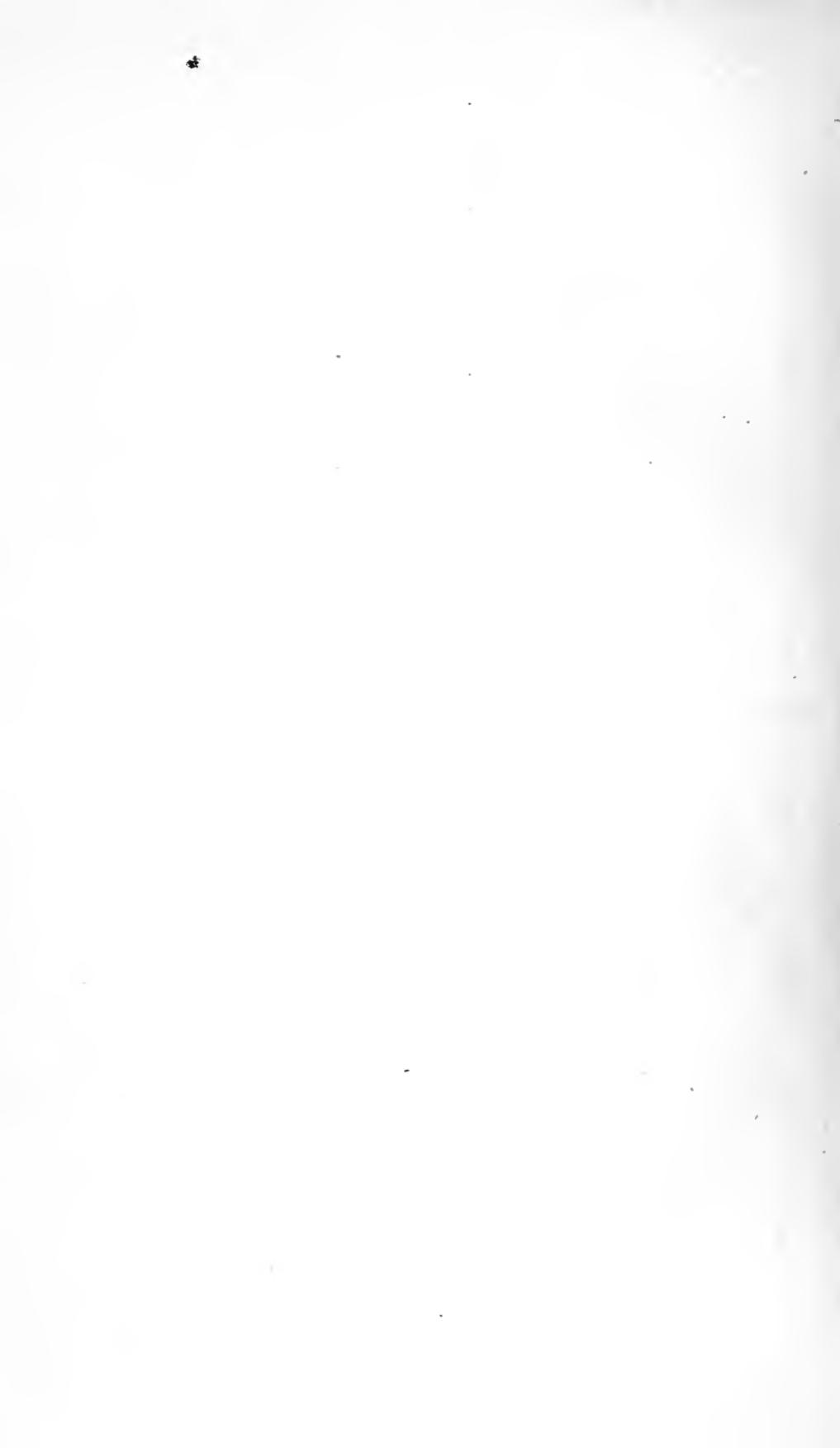
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SECTION I
RADIANT LIGHT AND HEAT

RADIANT LIGHT AND HEAT

CHAPTER I RADIANT LIGHT AND HEAT

The application of radiant energy to the treatment of disease, has received no little attention from therapeutists during the last decade. More earnest study and investigation of the agents which have always been recognized as essential to life, have resulted in the introduction of therapeutic methods which bid fair to give the various forms of radiant energy rank with the most valuable curative agents. Their skillful employment is fraught with little danger. To effect the best results however in the large class of cases for which they are indicated, a thorough knowledge of the requirements and limitations of technique is indispensable.

Radiant energy as emitted from the usual sources includes the transmission of light, heat, the Roentgen ray and the emanations from radium and other radio-active substances through the medium of the ether and air which are capable of setting up responsive vibrations in animal tissue. The effect of the various rates of frequency is normally to induce responses of the organs of special sense; each sense having perception of a wide range of vibration frequencies during health. The pressure sense and sense of hearing respond only to vibrations of substantial bodies in the form of gases or solids; while radiant light and heat are transmitted through the ether and are of higher frequency and shorter wave length, inducing responses relative to their intensity—of heat, in the terms of degrees, and of light, in terms of color.

The higher invisible frequencies are manifested only by the effects on living tissue, and by fluorescence of substances in which they are capable of setting up in other bodies thus exposed secondary vibrations corresponding with the visible light frequencies. Platino-barium-cyanide and tungstate of calcium respond to the ultra-violet and Roentgen ray frequencies with

a clear, nearly white fluorescence and willemite with green. The higher frequencies, to which the senses do not perceptibly respond, are ether vibrations emanating in Nature from the sun or radio-active substances or are produced from high volt electrical sources as the electric arc, and the Crookes tube, evolving from the former all of the frequencies of light, and also the invisible frequencies at either end of the spectrum —the ultra violet and infra-red or heat frequencies, and from the latter the various frequencies of the Roentgen ray, increasing as they do in frequency with shortening of wave length as the vacuum of the tube becomes higher.

It is readily appreciated that these various frequencies of ether vibration, affecting as they manifestly do human tissue, induce effects relative to their wave lengths and frequency.

When it is recognized that "heat is an energy of molecular motion with sudden changes of direction and velocity, when the molecules come near enough to one another" it is self-evident that the human body at 98 2-5° F. is a mass of matter in active molecular motion responding to heat, and coincidently responding to the influences of the other frequencies. Made up of active organic parts each fulfilling a rhythm of its own, particularly the thrill of the cardiac contractions transmitted through the coats of the arterial walls and the complexity of the vibrations of the nervous mechanism, it is manifest that when those functions are recognized to depend more or less upon external sources for their maintenance, that a loss of normal rhythm, or lost balance, would naturally be restored by re-establishment of the normal rate of vibration from such sources.

In accord with the law of harmonic vibration, it is probable that the tissues attune themselves from a source of mixed vibrations, as of the combined spectral vibrations of radiant light and heat, deriving therefrom by selection the kind of energy which sets up and restores functional activity. While this is true of the light and heat frequencies which are a part of normal living environment, the higher frequencies, which are not essential to health under normal conditions, as the radiations of the Roentgen ray and radium emanations, have a tendency to overwhelm the tissues exerting abnormal inhibitory influences. It is also true that the ether vibrations which constitute a normal environment do under extreme con-

ditions, as of prolonged exposures to the light and heat radiations of the sun, become inhibitory or depressing in their influence upon human life. Under varying conditions it will then be readily appreciated that the judicious employment of the wide range of vibratory radiant energy will be in a large measure capable either of restoring or inhibiting the vibratory energies or activities of the animal organism.

These higher frequencies of radiant energy conserve the chemical actions and the more gross and energetic mechanical agencies, as certain electrical modalities, mechanical vibration and exercise conserve the mechanical demands for relieving stasis and infiltration, and also increasing the activity of the grosser functions of the organism.

From the point of view suggested by the above premises, it will be recognized that the study of the application of these vibratory agents to therapeutics suggests the investigation of the principles of adaptation of external vibratory energy to the restoration of the body, properly sustained, to its normal vibration in all its parts, as evidenced by the revival of health with the restoration of functional activities.

It must always be recognized that while external agents exert temporarily the energy of motion—vibration—a sustaining pabulum or tissue food is essential to its maintenance. These two—*imparted activity* and *nutrition* constitute a *vis-à-tergo* leading to the restoration and preservation of the functional activities.

Radiant light and radiant heat from the same general characteristics, render the actions of the spectral and infra-red or heat rays, similar in their effects upon living tissue, and as they are emitted together, and neither is contraindicated, in most cases it is customary to treat of them in unison as radiant light and heat radiations. It should be borne in mind that the *incandescent* or *mercury vapor* lamps or arc lamps, employed with intervening glass screens or glass lenses, cut out or absorb most, if not all, of the ultra-violet frequencies. This, however, is generally desirable because during courses of light treatment with the ultra-violet frequencies included, as when employing direct sunlight or the electric arc, the skin soon becomes tanned; afterwards largely impeding the penetration and consequent beneficial action of all of the light frequencies. The irritating and tanning ultra-violet frequencies

seem therefore to be a provision of Nature for protection against overstimulation of the deeper tissues of those who are much exposed to the sun's rays, in the tropics and during the summer in the temperate zones.

Radiant light and heat are usually derived from the same sources and constitute "a form of wave motion projected by the wave motion of the luminiferous ether," and differ only in kind, being capable of conversion one into the other, as light passed through an object which absorbs a part of the frequencies is converted into heat units,—as demonstrated in the passage of light through blue glass. The fact that they are radiated from the same sources and differ only in frequency of vibration and wave lengths with the objectionable higher frequencies cut out indicates their general employment in unison.

The physical characteristics and the differences in those characteristics as exerted by the various frequencies, may be considered with reference to frequency or rate of vibration and wave length as affecting (1) penetration, (2) refraction, (3) polarization, (4) fluorescence, (5) color, and (6) heat production; and as affecting human tissue, (1) inducing hyperemia, (2) producing tanning, (3) superficial and deeper effects upon metabolism, (4) actinic actions—affecting oxidation and germ life, and (5) reflex effects upon functions remote from the surface through the end neurons and nerve connections.

The frequency and wave length of the radiations of light vary from 450,000,000,000 per second of red to 850,000,000,000 of violet, between which range the rates of the other frequencies. The wave length shortens relatively as the frequency increases; and it has been also practically demonstrated that the penetration diminishes with the wave length. In other words, the infra-red or heat radiations, of the lower frequencies of light, have relatively greater power of penetration than the ultra-violet and higher light frequencies, blue, indigo and violet. This rule of decrease in penetration applies with increase of the angle of refraction as the frequency increases until, as Lodge has said, "the wave lengths are found that are smaller than the atoms, when they go straight on," as do the x-rays.

Refraction.—When a ray or beam of light passes between media of varying densities, it is bent out of its direction, both at the entrance to the denser and the exit into the rarer

media, being bent at an angle towards the perpendicular let fall to the plane of the surface in the first instance, and from it in the second, Fig. 1. It is by refraction through a prism that white light is resolved into the prismatic colors. A beam of white light allowed to fall upon a transparent prism is divided

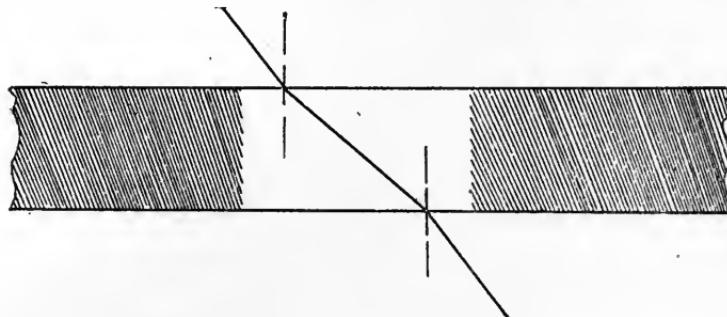


Fig. 1.—Illustrating Refraction.

into its component parts. Beginning with the more refrangible, the order in which the colors occur are as shown in Fig. 2; passing from the violet to red, with the varying degrees of refraction, and the varying colors as may be shown by throwing

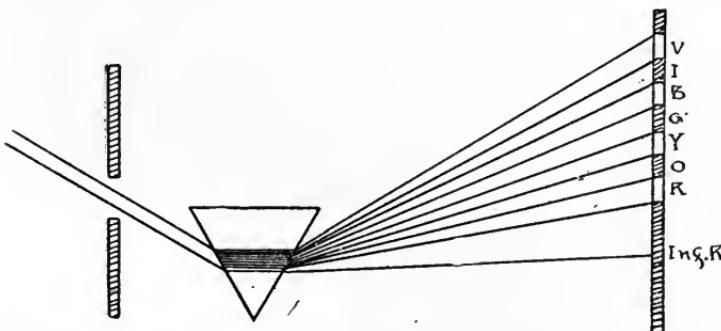


Fig. 2.—Showing Refraction of a Beam of Light Passed through a Prism, and the Order of the Spectral Colors.

the refracted rays upon a screen in a darkened room or as seen in the rainbow.

Reflection is the property of light, whereby a pencil or beam of light thrown against certain surfaces is caused to be reflected backward or at an angle according to the obliquity at which the rays strike the reflecting surface, the angle of incidence being equal to the angle of reflection; i. e., if a per-

pendicular be drawn or let fall to a reflecting surface, the angle formed between the line of light and the perpendicular will be equal to the angle between the opposite side of the perpendicular, and the line of the reflected radiation, Fig. 3.



Fig. 3.—Showing Angle of Incidence and Angle of Reflection.

The laws of reflection obtain also with the reflections from concave mirrors, the proximity of the luminous body to the reflecting surface varying the focal points of the radiation,

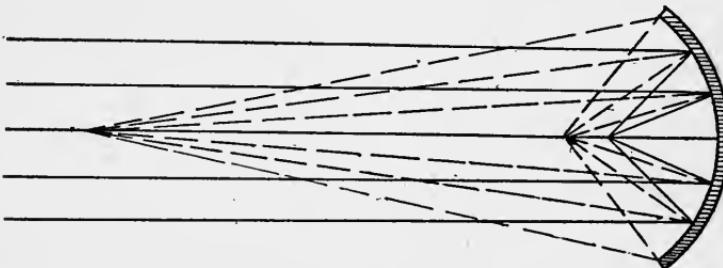


Fig. 4.—Showing Reflections in Parallel and Convergent from Concave Mirror.

Fig. 4; or when placed at the requisite angle, producing parallel radiations as illustrated in the accompanying drawing. Another matter for particular consideration to the therapist is

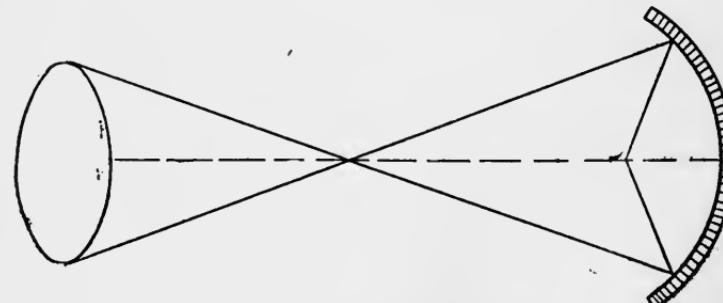


Fig. 5.—Indicating Crossing of Convergent Rays and Dark Spot beyond, within Which Shimmer Appears.

the fact that beyond the focal point where the rays cross, a ring of light is produced surrounding a dark center, Fig. 5.

Within this light ring a violet shimmer appears which will mislead the unsophisticated, and may be made use of to lead physicians unsuspectingly to believe that this shimmer is the violet or ultra-violet radiation, which is quite false. It should always be considered, in investigating an apparatus, where the focal point will fall, and with the understanding that, except immediately beyond the focal point, where the invisible ultra-violet is present, the rays are dispersed in such a manner as to be of little use for therapeutic purposes. From the incandescent light, with parabolic reflector, the point of greatest intensity of heat would be at about the focal point, the degree of intensity diminishing as the object is placed nearer to the reflecting surface.

Polarization, as of interest in the consideration of light, consists of a double refraction that occurs when light passes through certain substances as Iceland spar, and is not of significance as pertaining to therapeutics.

Fluorescence, as induced in certain substances, is a secondary effect arising from the projection of radiant energy. Some substances, as sulphide of calcium, continue to fluoresce for hours after prolonged exposures to radiant light. Certain substances also fluoresce under the radiations of the higher invisible frequencies of radiant energy only, as the fluorescence of willemite, tungstate of calcium, and platino-barium-cyanide under exposures of ultra-violet and x-ray radiations. It is by this property of light and matter that we are able to discern the presence of the invisible frequencies.

Color is the manifestation of the various degrees of refrangibility of the spectral rays of light,—the radiations that constitute light. Some writers of recent date have erred in the use of the term light, applying “x-light” to the x-ray, and “ultra-violet light” to the frequencies above the violet; whereas, only the visible frequencies constitute light. The ultra-violet, x-ray, and infra-red are the invisible frequencies of the spectrum, and are discerned only through the means of fluorescence, and the effects upon sensitized plates, with the higher frequencies, and by the thermopile as registering the radiations of heat with the lower frequencies. It will be seen that radiant light and radiant heat are very closely allied; the lower frequencies of light, the red and orange, containing heat radiations, as evidenced by the thermopile. The infra-red or heat

rays have their maximum heat intensity at a short distance from the red; but are present to a less degree at a distance from the red about equal to the range of the visible spectrum from red to violet. The higher frequencies of the ultra-violet and the x-ray are devoid of heat radiations. This fact readily explains the difference of the temperature of incandescent bulbs transmitting the red, orange and white light, as compared with the blue or violet bulbs in which the lower frequencies are absorbed; the heat of the latter becoming markedly more intense under radiations employing the same candle power than the transparent red or orange incandescent bulbs. In other words, a secondary radiation is induced from the glass of the violet bulb plus the infra-red, radiations from the conversion of the lower frequencies into heat by absorption, which renders the heat radiated of greater intensity from the bulbs of blue or violet.

The physical properties of light above described are of interest only in therapeutics, as defining the properties of the agents employed, the principles of which are significant and suggestive as to the effects produced upon the human organism.

The effects of radiant light and heat upon human tissue are complex from the nature of things, and not always easy of determination; as the processes of metabolism are so difficult of demonstration—the building processes of anabolism, and the taking down and removal of effete materials of katabolism. These metabolic processes, dealing with the appropriation of the nutrient circulating fluids, and combining both physical and chemical qualities, indicate the necessity of incessant activity, with the supply of the necessary pabulum for repair relative to the activities of the organism as a whole, or the part of the organism in question.

If light and heat energy are necessary to the carrying out of the body's normal processes, most living creatures requiring light and heat for the maintenance of health, the effects are prerequisites.

The chemical processes of the human body in a state of health, without exercise, are capable of supplying the requisite amount of heat to resist only moderate degrees of cold, requiring an increased chemical action and tissue combustion for the maintenance of the normal body temperature unless a surrounding temperature approaching 60° to 80° F. is maintained,

otherwise the escape of body heat must be prevented by clothing of non-conducting material to prevent cooling by convection.

The chemical actions of light, as inducing oxidation and actinic effects, are irritating and destructive, unfavorably affecting certain forms of germ life, and for this reason notably of value in therapeutics.

Tanning of the skin, by the effects of radiant energy, is induced by the higher frequencies, particularly by the invisible ultra-violet radiations. This is demonstrated in the experience of those who have used the high candle power incandescent lamps and light baths, when numerous prolonged exposures, made from these sources, invariably have not produced tanning; whereas, by the employment of the arc light, or the arc light bath, or by the localized treatment by high candle power arc lamps, rich in the higher frequencies, tanning invariably results. The writer has verified this from his own experience, and from this fact has abandoned the use of the arc light and ultra-violet frequencies, except with the employment of intervening glass screens, in the treatment of conditions in which stimulating and metabolic influences of the penetrating rays are indicated.

The hyperemia induced by the action of these frequencies which is associated with tanning, is very superficial but painful in its effects, in many cases inducing vesication of the skin, and therefore except when such effects are desirable, is contra-indicated. It would seem that the main object in nature, so far as the human race is concerned, of the ultra-violet and higher visible frequencies, is to effect tanning in order that white races living in the tropics or during the summer seasons in temperate zones, who are much exposed to the sunlight, may not be overstimulated by the penetrating action of the stimulating rays of light and heat of the lower frequencies. It is an undoubted fact that in the course of centuries, peoples who live constantly in these climates have become dark-skinned races, as is notable in the Spaniards, Italians, and others living in the tropics or southern portion of the north temperate zone.

The induction of hyperemia by the actinic effects of the higher frequencies, and from the combined action of all the frequencies of light, together with the radiant heat, are demonstrated to be capable of increasing positive chemotaxis, hasten-

ing the destruction and release of the tissues from deleterious substances, or forms of germ life present in them. The degrees to which this may be effected will vary with the character of the radiations as to volume and intensity.

The effect of light and heat radiations upon metabolism is to quicken the functional activities of the cells thus stimulated, promoting elimination through activity of the sweat glands, and inducing an increased influx of blood associated with the hyperemia produced, thereby favoring local nutrition and elimination. The application of intense heat and light to the peripheral neurons undoubtedly also stimulates reflexly greater activities in parts and organs remote from the site of stimulation. This is clinically demonstrated in the beneficial influence of light upon tissue building, and increased body weight, probably by influences both anabolic and katabolic. These effects, in a general way, indicate the therapeutic employment of light, and place it in the field as one of the valuable physical therapeutic measures.

CHAPTER II

SOURCES OF RADIANT ENERGY

The sources of radiant energy are both natural and artificial.

The natural sources are the sun, radium, uranium and other radio-active bodies; the sun alone in connection with this chapter calling for consideration.

The artificial sources are the electric arc, incandescent, and mercury vapor lamps, and the Crookes tube, all electrical sources; and others not practical for therapeutic purposes, including all flaming or burning materials, which emit radiant light and heat.

I. The sun, the natural source of light, furnishes all that could be desired when employed in conjunction with surrounding conditions and the necessary means for facilitating condensation, direct radiation, and in connection with various arrangements for filtration when desirable.

The variations in weather conditions in most climates, however, render it as a source of radiant energy rather too capricious for a practical means in therapeutics.

II. The electrical arc, as an artificial source of radiant energy, has been employed since the first introduction of artificial light in therapeutics. It possesses the advantage, especially when generated in connection with iron cored electrodes, of evolving rays particularly rich in the chemical or ultra-violet end of the spectrum. There are disadvantages in the administration however, when it is to be employed for the general or constitutional effects in that it cannot be applied directly over a patient, as when resting in a recumbent position, because of hot flying particles from the consuming carbon electrodes. Another disadvantage is that the relative amount of current consumed in the production of a given amount of radiant light and heat is much greater than with the high power incandescent lamp. In the enclosed light bath employing sufficient candle power to produce the desired radiant light and heat effects, it is impossible for some patients, and all patients under extreme conditions of time and intensity, to inhale and withstand the gases

thrown off from the arc lamps. These gases are composed largely of nitrous acid and ozone, evolved by the electric arc. Furthermore, when it is desired to produce profound, combined light and heat effects, for a long period of time, the ultra-violet rays, as stated in the previous chapter, induce too great a degree of hyperemia of the skin, which is followed by marked tanning, due to the peculiar action of the higher frequencies. However, in certain cases, the induction of intense hyperemia may be desirable, but the tanning interferes largely with subsequent beneficial effects when it is desirable to continue administrations of radiant energy to the deeper tissues. For the treatment of local infectious processes, as in lupus vulgaris, with the employment of intense focused light, rich in ultra-violet, the arc light is indicated in some cases.

III. The incandescent light properly fills the widest field of therapeutic indication. This type of lamp combines a large percentage of radiant heat which, when focused or from lamps of high candle power, is rich in luminous rays—rays which penetrate deeper into the tissues than the radiations of the higher frequencies in which they are deficient. A light of this sort is always most convenient of application, as it can be applied directly over the patient while reclining; with the advantage that a maximum surface is receiving the radiations while the opposite surface is not exposed during the administration. Another advantage is that the light may be moved back and forth over the surface with the greatest convenience and by the patient himself during applications to the front of the body. Another advantage of the incandescent light is that it is depleted of the ultra-violet radiations and may therefore be applied, if desirable, for a longer time without danger of producing a disagreeable hyperemia or eventually tanning the surface of the skin, thereby interfering with the maximum degree of therapeutic efficiency.

IV. The mercury vapor lamps have been employed by some for general applications but to the present time have little recognized therapeutic value. The radiations produced by these lamps are rich in the higher frequencies, but the red and infra-red are absent; and as the ultra-violet frequencies are filtered out by the glass in passing, they possess no advantage over the incandescent lamps, but a decided disadvantage in that the red and heat rays, which are most penetrating and

effective, are to a very large degree absent from this type of light.

There have been several types of arc lamp manufactured and used for therapeutic purposes.

The marine search light, manufactured by Bogue & Co., of New York, is provided with a parabolic reflector and movable carriage, and self-adjusting device for maintaining the carbon

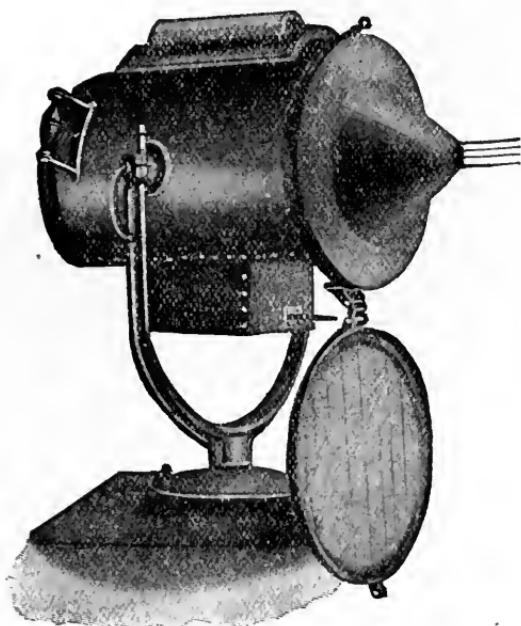


Fig. 6.—Marine Search Light.

electrodes in contact (see Fig. 6). The movable or adjustable platform may be so regulated as to vary the divergence or convergence of the rays whereby either parallel rays or focused rays may be projected upon the patient. The author's apparatus has also been provided by him with a hood and water cooling device, whereby the rays from the arc may be focused and emitted through plain rock crystal lenses for use for the treatment of one patient instead of four as by the arrangement of Niels Finsen, as employed for the treatment of lupus or other conditions in which this method of treatment may be indicated. A blue glass screen is also provided with this lamp.

The actinolite, one of the older types of arc lights, focuses or renders the radiations parallel or divergent by means of a movable glass lens. This lamp was manufactured by Kliegl Bros., also of New York, and is of varying capacity. It possesses the same disadvantages as the other arc lamps except that the light being passed through glass lenses the ultra-violet radiations are cut out or absorbed.

Another arc recently put upon the market by Frank S. Betz, of Chicago, (Fig. 7) is practically after the same idea as the

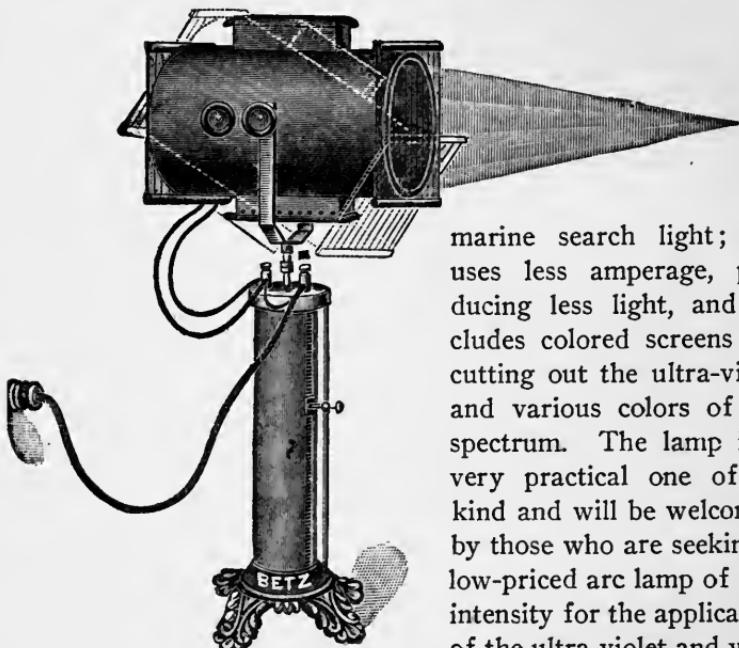


Fig. 7.

marine search light; but uses less amperage, producing less light, and includes colored screens for cutting out the ultra-violet and various colors of the spectrum. The lamp is a very practical one of its kind and will be welcomed by those who are seeking a low-priced arc lamp of fair intensity for the application of the ultra-violet and various other radiations at the discretion of the operator.

The solar arc lamp is of cheaper and simpler construction and provided with an adjustable arc and parabolic reflector, but employs less amperage and consequently produces less radiations. It must be observed in connection with this lamp and other arc lamps provided with parabolic reflectors, that as the arc is drawn from the reflecting surface, where at the focal point the radiations cross, a shimmer which the uninitiated are sometimes led to believe are violet radiations appears within the center of the light ring. As a matter of fact, this is the dark field beyond the point where the focused rays cross. (See

Fig. 5.) The same is true beyond the focal point of the incandescent lamp, provided with a parabolic reflector.

The elaborate apparatus of Neils Finsen consisted of a 90-ampere arc placed in the center, the radiations being projected through four tubes, and condensed through rock crystal lenses and the heat rays filtered out through ice or cooled water placed in the tube. Four patients placed at the four angles were treated at one time with the involved surfaces pressed against the outer lens of rock crystal, to render the tissues anemic, a necessity demonstrated by the experiments of Finsen. This apparatus has been but little used in this country, though several of the apparatus have been installed, because the ultra-violet rays are indicated in such a limited number of cases, particularly the types of lupus which are very rare in this country; and because, immediately following the introduction of the methods of Finsen, it was demonstrated that the x-ray was more effective in the treatment of these conditions. A much less expensive and equally practical apparatus is the London Hospital lamp first designed by Lortet and Genoud, many modifications of which have been produced, notably the one shown in the accompanying plate manufactured by the Victor Electric Co., of Chicago, New York and Boston. This type of lamp largely supplanted the more elaborate lamp of Finsen. It will prove of value in a limited number of cases which may not respond properly to the Roentgen ray, or in which the x-ray would sacrifice the part, as the lobe of an ear involved in a lupus process.

The electric incandescent lamps.—A large number of therapeutic lamps of the incandescent type have been put upon the market, all of which possess certain degrees of merit. A lamp of small candle power is valuable for applications to circumscribed areas, even for intense local treatment, but for their effects upon general metabolism and other purposes of administration to large areas are not practical, as they consume too much of the time, both of the patient and physician. Of the high candle power incandescent lamps, the most practical type is the so called Leucodescent lamp manufactured by Spear-Marshall & Co., of Chicago, (Fig. 8). One feature of this particular lamp is the character of the reflection, which instead of being by a parabolic reflector with one focal point, is constructed with a corrugated reflector and conical side reflec-

tors which project lines in parallel and crossing lines of radiation having two parallel fields of greatest brilliancy and intensity, which permit the operator to move the lamp about in such

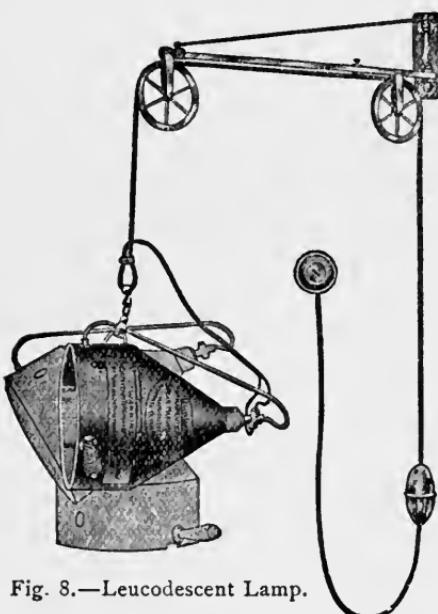


Fig. 8.—Leucodescent Lamp.

a manner that these two fairly large fields of intense radiation can be tolerated, as they cannot be when held in one position directly over the regions of tenderness or inflammatory involvement. At the same time the whole surface receives a liberal radiation of light and heat. In the writer's experience this type of lamp meets most acceptably the demands of the localizing incandescent lamp for general therapeutic administration.

The Minin light, devised first by Professor Minin of St. Petersburg, consists of a 50 to 100 c. p. incandescent lamp with a bulb of "natural-blue" glass, and provided with a reflector for projecting the radiations. While various claims have been made as to the anesthetic effects of this lamp, in the writer's experience the only advantage he has discerned, if it be an advantage, is the additional heat radiation from the conversion of the luminous and other frequencies absorbed by the glass into heat radiation. In other words, the Minin lamp becomes a radiator of heat, but in this respect does not seem to have any advantage over a high candle power lamp which may be raised and lowered over the surface of the patient, and the temperature regulated to the point of toleration without cutting out the generally beneficial light radiations. This statement is made from the author's observations, in view of the fact that Professor Minin and others have reported favorably of blue light.

The manufacturers of the *Leucodescent lamp*, Spear-Marshall & Co. have manufactured screens (Fig. 9) constructed of narrow strips of colored glass in three colors—

blue, orange and red. When fastened to the lower rim of the shield, only the rays of the particular color are permitted to pass to be administered together with the heat rays. They also make a small hand lamp (Fig. 10), the "midget," pro-

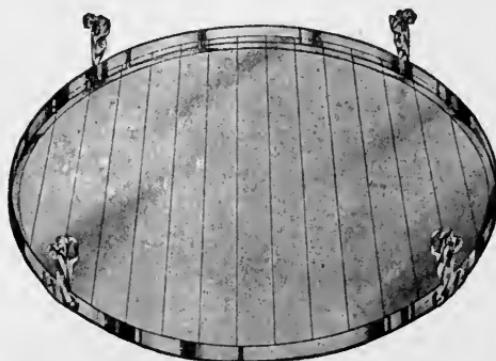


Fig. 9.
Leucodescent Screen and Small Lamp.



Fig. 10.

vided with 50 candle power bulbs of white and the other colors, instead of screens as used with the large lamps.

An incandescent lamp manufactured by the Victor Electric Co. is constructed with sockets for four lamps and provided with individual reflectors, so placed as to throw the light in practically parallel beams of light. The lamps that are em-

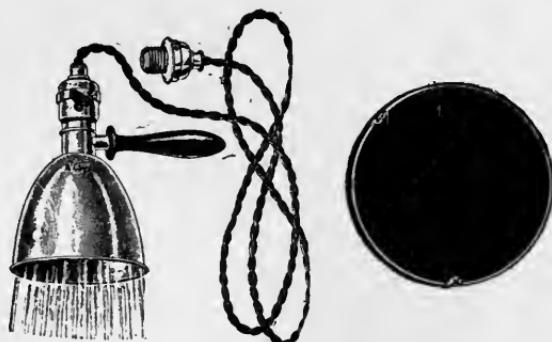


Fig. 11.—Small Victor Lamp and Screen.

ployed are of various candle power aggregating from 200 to 400 candle power for the four. One of the lamps from this group is provided with a handle and may be removed for the purpose of use as a hand lamp, similar to Fig 11, for local applications. These lamps are also provided with small

glass screens of orange, blue, and red which may be adjusted over the front of the small shield, whereby local administrations may be made of these various colors if desirable.

There are numerous other incandescent lamps manufactured of practically the same design as the small "midget" and hand lamps of the Victor and Spear-Marshall, and Frank S. Betz Companies, which are convenient for the treatment of local lesions in which only small areas are to be treated. When body or general treatment is required, however, too much time is necessary for the administration to make the small lamps practicable.

Another type of lamp, the *Göerl* lamp, in which the radiations are produced by sparking between balls placed in circuit, usually in the form of a triangle, so that sparks will pass steadily between the balls during the flow of the current, has been modified by the Victor Electric Company; and also in the Piffard lamp, manufactured by Waite & Bartlett. A type of this lamp for use with the static machine is also manufactured by the Van Houten & Ten Broeck Company. These lamps, by passing a considerable current through the circuit, produce a radiation that is fairly rich in ultra-violet frequencies, and may be used in lieu of the more expensive lamps for making application to certain superficial lupus patches, etc. As has been said before, these lamps furnishing the ultra-violet discharges are generally less efficient in their action than the Roentgen ray, hence their therapeutic value is not of so great importance.

The mercury vapor lamp, invented by Cooper Hewitt, and one of the most recent sources of artificial light, is peculiarly rich in the ultra-violet end of the spectrum. The fact, however, that the light produced is within a cylindrical glass tube, does not permit the radiation of the higher frequencies—the ultra-violet—and is deficient in heat radiations.

The Uviol lamp, Fig. 12, manufactured in Germany, is a mercury vapor lamp, a modification of the Cooper Hewitt lamp. The manufacturers have laid claim to the fact that the quality of the glass employed permits the emanation of radiations rich in ultra-violet, and some of the therapeutic results would seem to justify the claims. However, careful test made by the writer, in which it was endeavored to pass the ultra-violet rays through the glass tube, failed to produce the characteristic

green fluorescence of willemite or the characteristic fluorescence upon a platino-barium-cyanide screen in a darkened room.

Light bath cabinets are properly of six types; the first two

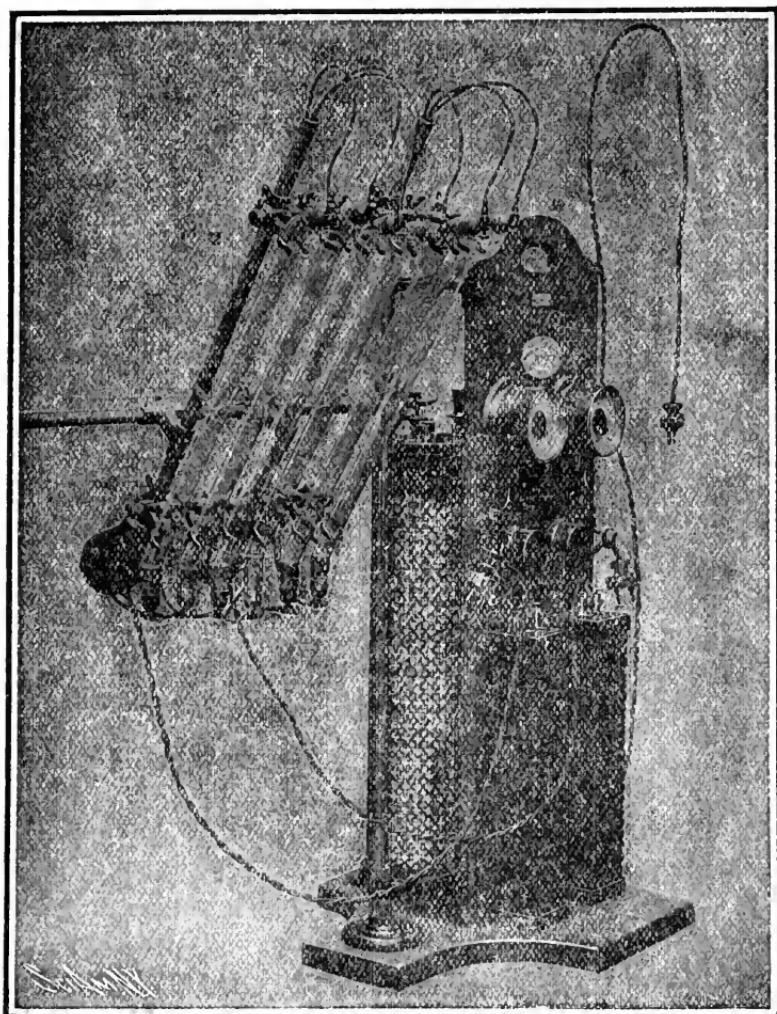


Fig. 12.—The Uviol Lamp.

with reference to the position of the patient during the light bath whether (1) sitting, or (2) reclining (upright or horizontal), and two with reference to the character of light employed, (3) arc or mixed baths, and (4) the distinctly incan-

descent bath cabinet, (5) a local cluster of lamps for treating joints or localized inflammatory areas, and (6) another type in which a high power incandescent lamp is applied over a long narrow box cabinet with a glass window. These may be still further varied by the employment of varying colors in the baths; for which, however, there seems to be very little indication; because, on general principles, the employment of white light is in most cases to be preferred to any one of the prismatic colors.

The types of construction of light bath cabinets are based upon two principles; (1), the position of the lights and reflectors in such a manner that the radiant energy will be directed towards the body of the patient; and (2), that the capacity of the cabinet shall be relative to the number of lamps in the space, or the degree of accumulated heat that it is desirable to administer to the patient; for as will be readily appreciated from the first lighting of the bath cabinet when closed, the temperature within the cabinet increases. The question, therefore, for consideration is, shall the cabinet be large enough to permit radiant light and heat to produce the effects of radiant energy upon the patient, or be constructed smaller in proportion to the number of lights installed in order that the heat accumulation in the smaller air space shall raise the temperature of the bath, that the mixed effects of radiant light and heat and accumulated convective heat shall permit the employment of a high temperature within the cabinet. As a matter of fact, the general-purpose bath could not combine these two qualities except some additional means be provided for increasing the heat within the bath cabinet, which may be readily accomplished by making provision within the larger cabinet for placing a number of large sized blue glass bulbs, which radiate a larger percentage of heat than the plain-glass bulb of equal candle power, when owing to the fact that the luminous rays are converted into heat by their absorption in the glass walls of the colored bulb, convective heat is evolved, which effect will be readily appreciated by placing a finger against a colorless glass bulb and then against a blue one—both radiating.

In the construction of a light bath cabinet, several features are to be considered. (1) The cabinet construction should be of good workmanship if not to be lined with metal sheeting, which

latter plan is generally objected to by the fire-underwriters, owing to the possibility of short circuits through the metal lining of the cabinet. This, however, may be obviated by the employment of wood pulp sheeting or smooth surfaced asbestos sheets, placed in position and coated with white enamel paint. (2) The interior shape of the cabinet should be such as to throw the light generally towards the center of the cabinet—the space to be occupied by the patient. The shape of the cabinet in the interior should therefore, particularly the upright type, be in the form of a hexagon or an octagon. The character of the reflecting surfaces should be preferably of white enamel paint or white porcelain, reflecting mirrors adding very little of the real utility to the cabinet. Parabolic reflectors of polished metal in position back of each of the incandescent or arc lamps, if properly focused will aid in directing the radiations towards the position of the patient in the cabinet. (3) The size of the cabinet should be such that the individual lamps will be located at about 14 to 18 inches from the space to be occupied by the patient, in order that the patient may not be apt to come against the sharp points of the incandescent lamps, which may, however, be placed at varying angles, preferably at an angle of 45°, as the greater luminosity is projected from this angle with the ordinary incandescent bulbs; whereas with specially constructed bulbs, such as are used with the smaller hand-treatment lamps, provided with parabolic reflectors, a larger amount of light is projected in the line of the long axis of the lamp.

In hospitals and offices where invalids of all types are to be treated a *reclining bath* possesses an advantage if high temperatures are required, particularly in patients having impaired cardiac force, because with the patient reclining there will be no danger of syncope during the administration; whereas in the upright cabinet the dangers of this sort will preclude the use of the light bath with a large class of patients for which its use is indicated. For the family light bath cabinet, however, in most instances, the *upright cabinet* would fulfill the purpose.

The incandescent bath possesses the same advantage for therapeutic administration over the arc light that the large incandescent lamp does over the high candle power arc light, as previously stated; because while it is rich in the penetrating lumi-

nous rays and heat radiations, it is devoid of the irritating effects of the higher frequencies of the arc light, particularly the ultra-violet, and also from emanations from the arc of nitrous acid, the fumes of which are very irritating as they

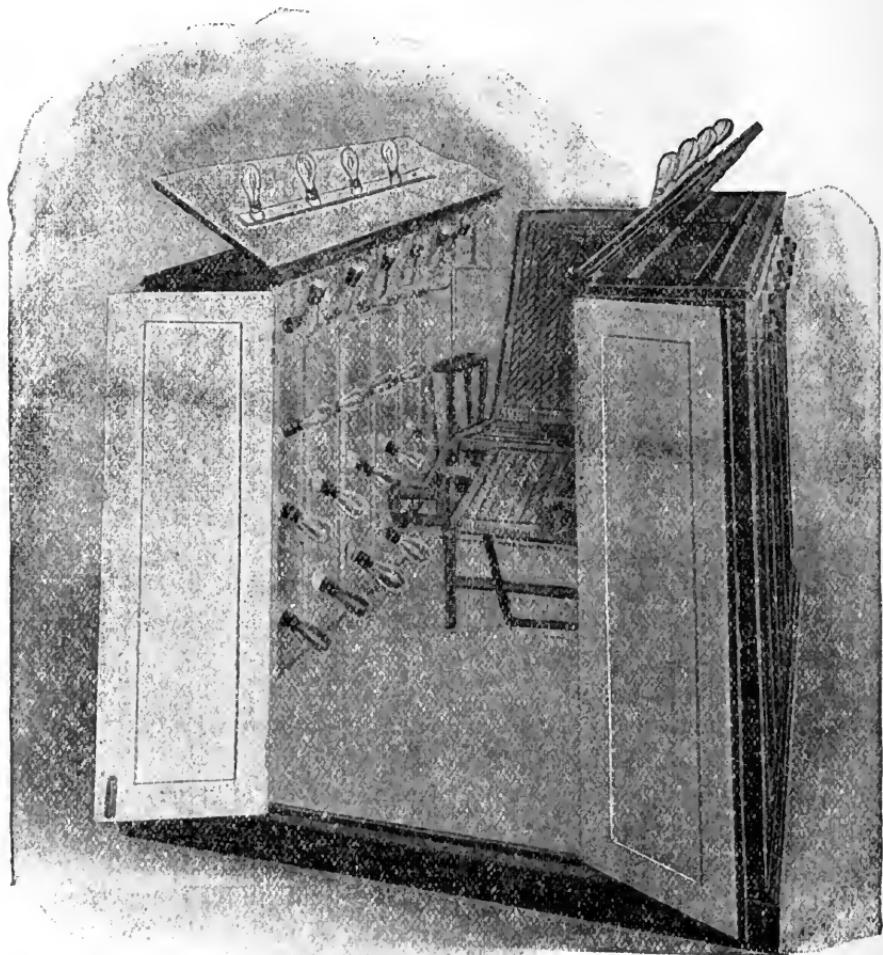


Fig. 13.—Author's Bath Cabinet.

escape from the cabinet or when the cabinet is opened—producing disagreeable irritation to the lungs and fauces of the patient when the fumes are inhaled.

If the *arc light* is possessed of any advantage in therapeutics over the incandescent for the treatment of any class of cases, it resides in the fact that the reflex effect from the irritation

of the skin by the ultra-violet radiations, or other action of these radiations upon the skin, possess some particular advantage in certain skin conditions. For the administration of radiant light and heat for general tonic and metabolic effects,

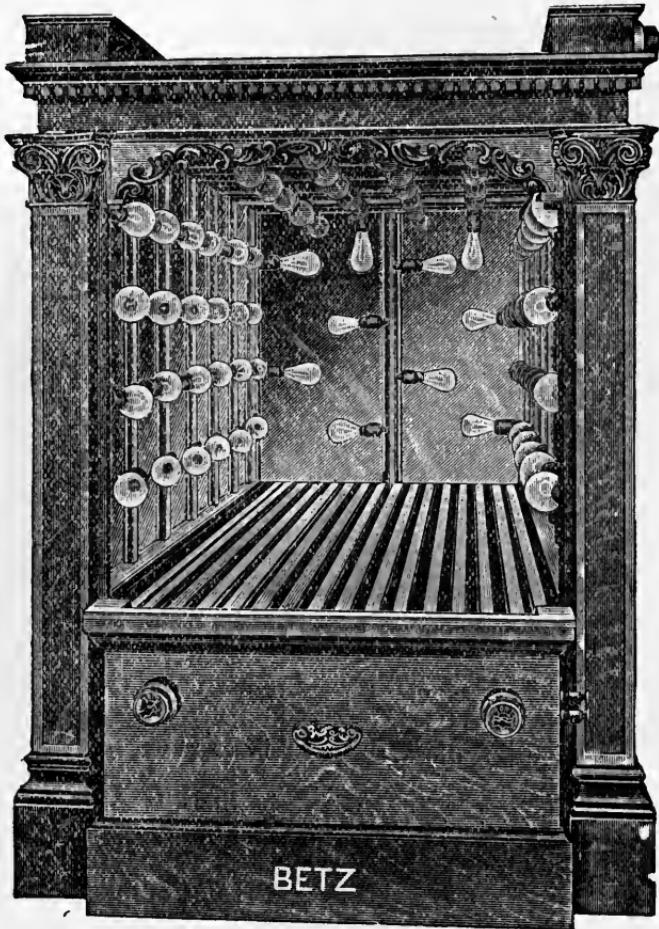


Fig. 14.—Betz Reclining Bath Cabinet.

the radiations having the higher frequencies filtered out are in all instances to be preferred.

Special types of light bath cabinets have been constructed by various manufacturers to meet the indications for the treatment of most conditions.

The writer's bath cabinet shown in Fig. 13, was constructed by E. B. Meyrowitz of New York and was designed to treat patients in a recumbent position. The bath is provided with

60 sixteen candle power incandescent lamps, and with an open work chair upon which the patient reclines. A door is placed at the one end, and folding doors over the top, with an opening for the protrusion of the patient's head at the opposite end.

The bath cabinet shown in Fig. 14 is manufactured by Frank S. Betz of Chicago and has the advantage of a sliding table

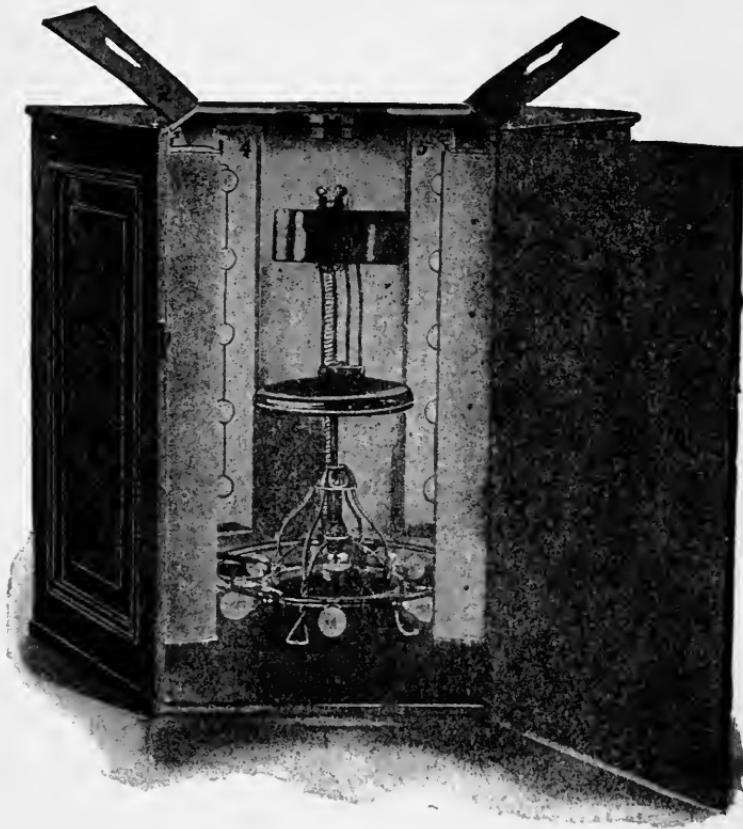


Fig. 15.—Kny-Scheerer Upright Bath Cabinet.

which permits the patient to be pushed into the bath and withdrawn at the end of the treatment. The lights in this bath are arranged on all sides and beneath, the patient reclining upon the slatted sliding framework.

The upright bath cabinet shown in Fig. 15, is manufactured by the Kny-Scheerer Co. of New York, and is constructed for giving the treatment in an upright position. The bath is provided with mirrors and a variety of colored bulbs, and is exquisite in its details of construction.



Plate II.—Treatment with Small Bath Cabinet and 500 Candle Power Lamp.

Another type of bath cabinet has been manufactured by Spear-Marshall Co. for the writer and consists of a portable collapsible box, the sides of which are made of three thicknesses of veneer, and finished within with white enamel. One end is notched out for the head of the patient. Over the cabinet is fitted, when the patient is in position, a glass window. The object of this cabinet is to place it over a patient, who is reclining for treatment upon a long operating table. It is very convenient for use when space is an element to be considered, and effective in administering a combined radiant light and heat and convective heat bath by swinging the five hundred candle power lamp over the window of the cabinet (see Plate II).

CHAPTER III

PHYSIOLOGICAL EFFECTS OF RADIANT LIGHT AND HEAT

In the consideration of the indications for radiant energy in therapeutics, a rational basis for its employment calls in each class of conditions, for a consideration of the relation of the physical properties of the agents to their physiological effects upon the tissues.

The forms of radiant energy penetrate the tissues to varying depths producing direct physical effects, vibratory in character, and secondary chemical, nutritional and reflex nervous influences upon metabolism and the nervous mechanism. When radiant energy impinges upon the tissues without passing through, heat is evolved in the tissues so influenced, in contrast to the Roentgen ray, which passes through the tissues as light passes through the window pane, without the evolution of heat.

When heat is evolved at the periphery from the impinging of radiant light and heat radiations, the effect is not only local but general. A glow of warmth is transmitted throughout the body by the heated blood stream, which also, when long continued or extreme, awakens the activity of the excretory channels through the sweat glands, and maintains the body temperature at normal, through the cooling influence of absorption by the latent heat of evaporation, thereby setting up a complex influence upon metabolism, far-reaching in its influences, especially so, when these processes so essential to healthy existence are dormant.

It is not heat alone that influences metabolism, but the penetrating luminous rays, undoubtedly, act directly upon the blood cells in the circulating streams, and this influence becomes marked as the irradiated tissues become hyperemic under prolonged exposures, and in a short period of time the blood of the whole body has been exposed to the oxidizing and steriliz-

ing influences of light. No prolonged local administration of radiant light and heat can therefore be considered local, only; for the effect is coincidentally general and beneficial in all conditions of impaired or perverted nutrition and poor metabolism.

The local influences of radiant light and heat from the usual sources are undoubtedly due chiefly to the heat effects, very similar effects being induced by convective heat as shown in another chapter.

The hyperemia induced with the vasodilatation is undoubtedly the effect which exerts the greatest local influence upon the two types of inflammation; in the simple type relaxing the tissues, relieving tissue tension and pain; while in infectious inflammation vascularization with relaxation and softening permits a greater supply of fresh arterial blood to invade the infected area carrying Nature's scavengers, the phagocytes, under favorable influence of oxidation where their presence is demanded. Where infection is present there is the additional advantage from these radiations derived from the destructive or, at least, inhibitive action of radiant light and heat upon the germs walled in, in the field of infection.

Clinical experience, in this connection, justifies the assumption that radiant and convective heat and radiant light, to which the higher, less penetrating frequencies are not essential, increase most favorably local phagocytosis and coincidentally render the germs inert; a combination of circumstances always effective when employed with energy in the first days of superficial infectious processes, and advancing recovery at any stage.

It has to all intents been demonstrated by Neils Finsen that when the tissues are rendered anemic during exposure to ultra-violet radiations, their action is destructive superficially to germ life. It was the object of Finsen and his contemporaries, however, to carry the exposure to the extent of reaction; in other words, to the extent of profound hyperemia which, in the light of effects produced in the treatment of infection under conditions of hyperemia, would indicate an important part as played by such tissue engorgement. On the other hand, the best results were obtained when the tissues were rendered anemic during treatment, manifestly due to the antigermicidal action of the ultra-violet radiations. The final result is undoubtedly due to a combination of the two

effects, germicidal and the induction of the increased local phagocytosis of hyperemia.

It will be observed, therefore, in the treatment of all local or constitutional conditions by radiant light and heat radiations, that the effects are due to the same physiological effects, which may be summarized as follows:

I. The effects upon metabolism, local and general, are due to (1) the induction of increased local activity of elimination and tissue building; (2) diffusion of heat throughout the body by the channels of circulation; (3) the increased general perspiration induced by general diffusion of heat, when exposures are extensive and prolonged; (4) increased oxidation from heat induced, and the local action of radiant light upon the blood in the dilated capillaries; and (5) the effects upon the remote spinal centers due to peripheral stimulation of the end neurons by heat and light radiations.

II. The effects upon simple inflammation, unaccompanied by infection, is (1) to induce general tissue relaxations with relief of pressure and pain; (2) by increasing local metabolism and elimination to relieve the tissues of the irritating products of defective metabolism as present in conditions associated with myalgias, infectious arthritis, eczema, and similar conditions; and (3) in conditions of mild traumatic injury, treated promptly after injury, to remove early stasis and cure the condition, but is ineffective after stasis with induration is established.

III. In acute and subacute infectious conditions alone, or in connection with other measures which inhibit germ processes or increase local hyperemia or both, (1) it increases local hyperemia in the region of infection with a relative increase of leucocytes—the phagocytes; (2) it inhibits the activity of the germs through the intensity of the radiant light and heat radiations, and (3) it stimulates the elimination of toxic materials, local and diffused, by the induction of perspiration and increase of tissue oxidation.

By these means local phagocytosis is stimulated, the germs inhibited and devoured and the toxic material eliminated.

IV. Derivative effects are induced when extensive exposures are made, rendering the surface hyperemic by prolonged applications of high candle power incandescent lamps over front, back, and sides, or by the arc or incandescent light bath and

by the coincident profuse perspiration induced; (1) lessening the quantity of blood in congested regions and the larger arteries and veins; (2) lowering arterial tension; (3) relieving an overworked heart; and (4) coincidentally promoting extensive elimination of the locked up products of poor metabolism.

CHAPTER IV

PRACTICAL METHODS OF APPLICATION OF RADIANT LIGHT AND HEAT

Success or failure in the employment of radiant energy, depends upon the attention to proper technic as to method, frequency, and duration of treatment. To succeed with any physical agent in therapeutics depends invariably upon the principles of treatment employed, comparisons of results depending as much upon the *men employing them* and the *methods employed* as upon the *diagnosis* of the condition. No physician who will not pay strict attention to the requirements of every case, with intelligent recognition of the requirements of each case, can expect to succeed with the application of radiant energy, or any other physical or other agent. Success here as in most things will depend upon the judgment as to choice of modality, and the knowledge and conscience of the physician in charge. No negligent nor heedless person can obtain creditable results from physical measures. The self-indulgent physician may succeed in some cases with placebos and suggestion, but in the cases that can be cured by physical agents only, an anatomical knowledge and the mechanical sense of the surgeon, together with a willingness to devote the requisite time, technique, and energy to every case, are prerequisites.

Local administrations of light should be employed with the primary idea of inducing local hyperemia, the degree, extent, and frequency of application to depend upon the requirements of the condition under treatment; acute inflammatory affections demanding frequent energetic localized applications, particularly in infectious cases—two to four treatments daily being essential, as in acute otitis media.

For the local employment with a view to relieving *local inflammation* the effects of the radiations from the incandescent lamps are generally to be preferred to the electric arc; (1) because the intense very superficial hyperemia induced by the higher frequencies of the arc light which are filtered out by



Plate III.—Method of Treatment with 500 Candle Power Leucodescent Lamp.

the glass of the incandescent bulb, induce tanning, interfering with the efficiency of subsequent applications, and, (2) because the risk of injury to the superficies from the higher frequencies, does not permit of prolonged application of the penetrating luminous rays and infra-red or heat radiations, from which the greater benefit is derived.

The hyperemia of the ultra-violet radiations is superficial and intensely irritating, while the hyperemia of the other frequencies is diffused and not irritating, with an added greater and unquestioned beneficial effect upon local and general metabolism.

The choice of lamps as to candle power will depend upon the extent of the local lesion and the indication for general as well as local treatment.

To circumscribed areas, as about the head and face, or furuncles or carbuncles, the small lamps with parabolic reflector (see Figs. 11 and 12) answer every purpose. When, however, larger areas are to be treated, or when general as well as local treatment is indicated, lamps of high candle power, preferably those which do not focus all of the rays, are to be employed.

For general or constitutional treatment, the lamps of high candle power which project practically parallel rays or rays crossing in various directions are only to be considered, for otherwise either time or thoroughness are compromised, or both.

The method of local administration in all cases as stated elsewhere is best effected with the suspended or swinging lamp, which can be brought close to the bared surface of the body and moved rapidly to and fro, until the surface is actively hyperemic. During the application the disengaged hand of the operator or the hands of the patient may be moved occasionally, in close contact, over the surface, thereby producing a remarkable cooling effect to the surface, and permitting more intense administrations.

The hand of the operator who constantly employs high candle power lamps, which is passed over the body of the patient, should be covered with a glove or towel.

The duration of the application—Either local or general treatment should be continued for some time after the first flush of hyperemia appears. In general treatment of the

trunk this is important, because a necessary degree of influence is not induced upon the circulating blood until a fair measure of hyperemia is present. In local inflammation of either type, it is important to carry the induction of local hyperemia to a greater degree of intensity than for general or constitutional effects.

Dermatitis or blistering is rarely effected by the radiant light and heat radiations from the incandescent light, nor from the incandescent light or the arc radiations passed through glass screens. When they do occur, however, as they may occur in very susceptible individuals (cases which are rare), the effect is transitory and should be treated as an ordinary burn; whereas, for the treatment of Roentgen ray dermatitis, no agency is so generally efficient as applications of radiant light and heat—the two conditions arising from opposite causes—one from excess of stimulation and the other from excess of inhibition.

The local Finsen method for local treatment of lupus and epithelioma, consists of the application of the ultra-violet radiation passed through focusing rock crystal lenses or rays focused by a parabolic reflector and then passed through plane lenses of rock crystal, with the lens or an outer compression lens pressing against the surface of the tissues irradiated, the pressure being employed for the purpose of rendering the tissues anemic.

Adrenalin applied to ulcerated surfaces to which it is impossible to exert pressure, as in the nose, has proved a valuable accessory.

The method of Finsen has been generally superceded, particularly in America, by the more satisfactory employment of the x-ray combined with static and high frequency applications, or the more recent employment of *Effluviation* as instituted by Rivière of Paris and later reported by Keating Hart under the term *Fulguration*.

General or constitutional treatment for effects upon metabolism may be administered either with the high power incandescent lamp, the patient reclining or in the light bath.

General treatment with the high candle power incandescent lamp is administered to the trunk, by application first to one part of the surface and then to another, swinging the lamp back and forth lengthwise over the body until the sur-



Plate IV.—Method of Treatment with the 1,000 Candle Power Marine Search Light Arc Light.

face is more or less hyperemic, after which the patient is thoroughly wiped off, dried, and dressed for vibration, which should follow, being administered in a systematic manner on the same table, to be followed in a well-regulated institution with an administration of the wave current with a large metal electrode over the abdomen or some other place indicated. Each of these procedures favorably influences general and local metabolism, acting as congeners in impaired constitutional states, and coincidentally in trained hands meeting local indications as well.

The light bath administered to the patient, seated or lying in the cabinet, is employed for its effects upon general metabolism, and if it possesses any advantage over the method described by use of the high c. p. lamps, it is due to the fact that a greater degree of perspiration is induced owing to the accumulation of a high temperature within the cabinet, and that the limbs as well as the trunk are exposed to the radiations. In administering light baths it is usually customary for the head to protrude from the top or one side of the cabinet. (See Plate VI, page 76.)

The duration and after treatment will vary with patients and conditions. When profuse elimination is sought, thorough stimulation of the sweat glands is indicated. The exposure should be prolonged to 30 or 40 minutes after which the patient may remain in the cabinet for a longer period or be removed to a couch and rolled in blankets and allowed to perspire for half an hour longer, after which he may be given a tepid shower bath gradually lowered to 60° F., and followed by a rub and mechanical vibration (general), and a static wave current treatment during rest. Instead of the shower an alcohol rub, vibration and static may be administered.

The treatment by vibration when scientifically administered is for many reasons superior to manual massage. The addition of the static treatment with a metal electrode applied over an enlarged or congested part as indicated is beneficial in all cases and should replace the period devoted to rest, exhilarating as it does the patient with its tonic influence.

With feeble patients or atonic conditions, the time devoted to the bath should not be prolonged beyond twenty minutes, and always followed when possible by vibration and static or auto-condensation treatment. When the static is not at

hand, and the auto-condensation high frequency current can be administered, it is indicated except in failing heart conditions and parenchymatous nephritis, in which high tension which is compensatory would be lowered by auto-condensation.

In conditions of plethora or otherwise abnormally high tension, associated with auto-intoxication, auto-condensation should constitute a routine part of the treatment.

Light baths or local high c.p. incandescent light treatments may be administered daily or on alternate days according to indications.

During administrations the pulse and temperature should be watched and treatment should be discontinued when temperature reaches $100\frac{1}{2}^{\circ}$ F., or the pulse becomes weak, rapid or irregular. Water may be given *ad libitum* throughout and after treatment, except in conditions of edema, where it is desirable to induce absorption of the serous effusion. It is customary and agreeable to the patient to cover the head with a moist towel, kept cool by frequently wringing it from a vessel of cool water.

CHAPTER V

TREATMENT OF SIMPLE INFLAMMATION

A classification of inflammatory conditions not characterized by the presence of some germ, either as a causative or consequent element, is often difficult. Conditions, however, arising from trauma or other accidents, as thrombosis or embolism, or as a result of faulty metabolism, or chemical or climatic causes, may be properly included in that category. So also may be considered some post-operative surgical conditions.

To consider the therapeutics of various conditions from the point of view of employment of one modality, as of light, would be misleading; it will therefore be considered proper to incidentally refer to other measures when treating of the applications of light to special conditions.

Conditions arising from defective or perverted metabolism as the myalgias, inactive secretions, and secondarily of arteriosclerosis, and perverted conditions associated with a vicious circle as with the reflex or functional neuroses are remarkably benefited by either local or general administrations of light.

With simple inflammation in contradistinction to infection, the curative effects of radiant energy will depend upon the extent and site of the lesion, as well as upon its chronicity. Injuries arising from superficial trauma, as wounds or sprains, of small joints, when treated early, may be largely relieved by the energetic application of radiant light and heat; whereas, in the treatment under similar conditions of large joints or deep-seated injuries, it will be quite inadequate in any event; as also in the treatment of inflammation in which stasis is fairly extensive and well established. It is absolutely useless to expect to relieve established stasis by treatment with this form of energy. For the relief of regions of local stasis, those who are familiar with their action and use, turn, naturally, to the static currents, which by throwing the involved tissues into activity, by the induction in them of rapid contraction and vibration, alternating with intervals of rest, which force out the infiltration, induce active metabolism and restore the lym-

phatic and blood circulation by pressing open the venous and lymphatic channels.

Pain is relieved by the application of radiant light and heat energy in regions of local inflammation on account of the induced relaxation of the tissues, the increased elasticity induced, relieving the pressure upon the nerve filaments, which is undoubtedly due largely to the effect of the radiant heat, as the same effects are derived to a less degree by applications of convective heat. This relief of pain should not delude any one into expecting to effect the cure of an inflammatory process in which stasis is once established for the effect is transitory, not curative. So in the treatment of sciatica, brachial neuritis, or severe sprains, excepting in the earlier stage of the affection, it is useless to expect to afford more than temporary relief from the administrations of radiant energy, whereas the employment of the static electrical currents insures prompt relief and the ultimate cure of these conditions, when accessible; i. e., when not within the chest or pelvis. Radiant light and heat, however, in connection with the static currents, are useful in the treatment of the forms of neuritis and joint inflammations, but must be employed in all cases, if at all, before the static current is applied, for the purpose of improving impaired local metabolism and nutrition in the tissues involved on account of the lowered function of the local nervous mechanism. Applied in these conditions it affords temporary relief from pain, but is not instrumental in removing the *bête noire* of simple inflammation—inflammatory stasis; its only function being to prevent inflammation at the outset; but when once established, radiant light and heat are absolutely impotent. When applied after static treatment, radiant light and heat relax again the tissues rendered tonic at the site of the lesion where accumulated infiltration, which is causing pain by pressure, has been forced out by the contraction induced in the tissues by the current.

Post-operative use of radiant light and heat employed immediately over the site of the operation is valuable from three points of view: (1) relief of pain; (2) the prevention of scar tissue in the line of sutures; and (3) the induction of active hyperemia which promotes nutrition, and, by the local increased presence of phagocytes in the region involved, lessens the possibility of local infection.

The same principle applies to the treatment of sites of local operation as well as of recent wounds and injuries, and for the same reasons. In myalgias, muscular sprains, and local areas of pelvic tenderness and pain, the beneficial effects of light and heat radiations will depend mostly upon relief of disturbances of metabolism or its effects upon the presence of local infection.

The method of treatment of simple inflammation, as well as of the infectious type of inflammation, consists in the localized application of light either from a small hand lamp of 50 to 100 candle power when the affection is slight, or the employment of a lamp of higher candle power for constitutional treatment or over large areas. In the treatment with light under these conditions, the application should be made at a distance that will give as high a temperature as the patient can withstand. The disengaged hand of the operator or the hand of the patient, when frequently passed over in contact with the surface during the administration of radiant light and heat, affords temporary relief, making it possible to keep up the treatment more energetically than otherwise. In applying radiant light and heat, the application should not be made with the lamp in a fixed position, but by constantly moving it about or swinging it to and fro over the involved area. The light should be employed in this manner for two reasons. (1) As great a degree of temperature cannot be applied persistently as interruptedly, and (2) because administered interruptedly, waves of contraction are induced in the tissues in response to the stimulating effect of the intense heat, and in the interval before the subsequent application there is a relative relaxation. The stimulation to contraction and intervening release, operates to a degree in the same manner with the alternate contraction and relaxation, occurring with the application of the static wave current, and so effects to a less degree the relief of local inflammation and stasis by tissue drainage.

The myalgias arise undoubtedly from the effects of defective metabolism under conditions of exposure to cold, draughts or wetting of the clothing; and are liable to arise after fatigue in those of inactive pursuits, particularly in the debilitated. Under the drug régime they are prone to become chronic, the soreness and stiffness often persisting with exacerbations for years. The affection is confined to no set or group of muscles, but is probably most common in the regions

of moderate, not of greatest activity, as the back and neck—lumbago and torticollis.

Muscular soreness in the limbs of the active soon disappears, due to the effect of such activity upon metabolism, and for the same reason they are less apt to be affected, whereas the dense less active muscles of the back are most apt to be involved—the regions of lesser activity. Lumbago and torticollis are the most common of the myalgias.

Lumbago, the type under consideration, should not be confused with a type of lumbar arthritis arising from sprain or traumatic injury of the spine.

While in acute myalgias radiant light and heat energetically applied are remarkably efficacious, in the chronic or more severe forms they do not compare with twenty-minute applications of the static wave current with an energy just short of inducing muscular contraction, followed by a few well-directed static sparks. Everyone who has become familiar with the use of static electricity has had success from the employment of the static methods. When used in association with static applications, as in other inflammatory conditions, the light should always precede the static treatment for reasons elsewhere given.

Various writers have reported results from the employment of light in lumbago.

Delvers reports a case of *lumbago* of two weeks' standing cured by the daily treatment of fifteen minutes each with a high c.p. incandescent lamp.

Russells of Chicago reports a case in a patient sixty years of age, of ten years' standing, as cured by sixteen fifteen-minute treatments. The treatments were given daily for six days and afterwards twice weekly. The radiant light and heat was administered with a high c. p. incandescent lamp, held as close as it could be borne. Four months later there had been no relapse. This patient also observed that without other treatment his bowels, which had been constipated, became regular after the sixth treatment.

CHAPTER VI

RADIANT ENERGY IN THE TREATMENT OF INFECTIOUS PROCESSES

The greater field of usefulness of radiant light and heat energy is found in its remarkable potency when associated with its congeners—the x-ray, high frequency currents, and convective heat in the treatment of infectious inflammation.

The attention being paid at this time to the subject of hyperemia, as influencing inflammatory conditions, has until recently ignored the important fact that local phagocytosis is the important effect, to which the writer called attention editorially in *THE JOURNAL OF ADVANCED THERAPEUTICS* for March, 1907.

Probably no investigation of recent days has been so full of significance and so fruitful of a revolutionary procedure as the treatment of local and general infections. The work of Wright in the discussion of opsonic indices of resistance, has opened up a new point of view in connection with the all but established theories of Metchnikoff of phagocytosis.

The fact that a region is rendered intensely hyperemic by the application of an agency which brings into the field of infection an increased influx of fresh arterial blood, rich in phagocytes, favoring a positive chemotaxis, as previously suggested by the writer, establishes rationally the indication of such measures as accomplish that effect for the treatment of all types of local infection. If an increased influx of blood were associated with a coincident relief of the induration which walled in an advanced infection, the employment of measures which induce local hyperemia would be involved in an element of danger, lest the infection might thereby be disseminated. In the relaxation of tissue which does occur, however, there is sufficient influx of fresh blood to the seat of the infection, carrying with it fresh phagocytes, to destroy the germs in an infectious process without the danger of extending the infection.

The means at present in vogue by the votaries of the meth-

ods of Bier, are fraught with elements of defect not found in the relief of local infection by the x-ray, light and the high frequency currents. Their errors reside in the facts, that (1) powerful suction produces a degree of mechanical injury to the local area, and (2) because the method by bandaging, cutting off the return venous circulation and preventing a normal influx of arterial blood, creating a deficiency of oxygen in the tissues, does not favor positive chemotaxis; because of the venous stasis induced. Whereas in the employment of radiant light and heat, two effects are produced unfavorable to the germs in the localized area, the tendency of which is opsonic: (1) the actinic action of light is adverse to the activity and energies of many types of bacteria, and (2) that the germs which exist upon the human body develop most favorably at the body temperature of 98.4, and are inhibited by the energetic application of radiant light and heat, while the blood stream, which is passing in and out of the area, is cooled at the periphery, returning constantly in a fresh stream to the site of involvement, thereby giving advantage to the phagocytes with adverse conditions exerted upon the elements of infection—in effect opsonic. It is furthermore probable that under the applications of radiant light and heat the phagocytes are more active in their war upon the bacteria.

It is already a well-demonstrated fact now that these theories as to the action of radiant light and heat upon the germs and phagocytes are correct; or that if not for the reasons given, they are for some other reasons; for clinically the effect upon local infection of these applications is that such processes do yield to the combined application of radiant light and heat, convective heat and the high frequency currents, all of which induce intense local hyperemia, and that the promptness and energy with which the effects are obtained are accentuated by the previous applications of the Roentgen ray, which probably is due to the fact that the ray sterilizes or inhibits the activity of the germs localized in the area of infection, while the elements of the blood which are shielded, except as they pass rapidly across the field of irradiation, are not adversely affected by the Roentgen ray.

It is the writer's practice in the treatment of infectious conditions, to make a prolonged—twenty to thirty minute—exposure to the Roentgen ray, making use of the energy usually

employed in the treatment of skin diseases for the purpose of inhibiting the activity of the germs and then permitting an interval of twelve to eighteen hours before the administration of the radiant light and heat, or high frequency current or both. The germs thus brought into a state of complete inhibition, increased by the delay, are so affected that the phagocytes brought fresh into the area, and in larger numbers, with the hyperemia induced by the radiant energy, devour them with a greater certainty. By this method it is possible to abort any accessible pus process prior to fluctuation.

Specialized employment of radiant energy offers a means in therapeutics especially valuable in the treatment of infectious processes,—tubercular, gonorrhreal, streptococcic, or staphylococcic; in fact, in all germ processes in which a local activity of the phagocytes is capable of destroying the infection. The possibilities of success or number or frequency of exposures will vary with the relative opsonic index of the individual under treatment. An important principle in the treatment by hyperemia resides in the internal resistance of the subject or patient—the capacity of the leucocyte to seize upon more or less of the germs in the field of infection. It is an important question whether a greater number of leucocytes caused to enter the field of infection, while each consuming a smaller number of germs, may not accomplish the same ultimate result as a smaller number of leucocytes under a higher index, or whether agents which inhibit the activity of the germs, as the x-ray, radiant light and heat, and the high frequency currents, by increasing hyperemia, do not coincidentally inhibit or lower the activity or resistance of the germs whereby their destruction is facilitated under any condition.

Clinically the writer has demonstrated the truth of each of these propositions, to the extent that it can be confidently asserted:—That in all infectious conditions susceptible to the leucocytic influence, at the proper stage, and in regions accessible to measures which induce intense local hyperemia, under conditions of positive chemotaxis, it is possible under favorable conditions to abort such processes by destruction of the cause.

No agent of equal intensity is more powerful in contributing the three most important elements favorable to the induction and natural effects of local phagocytosis than radiant light and

heat; and for such favorable action the ultra violet frequencies are not important; *viz.*, (1) the inhibition of germ life, (2) the induction of local hyperemia, and (3) increased presence of oxygen favoring a positive chemotaxis. The high frequency current produces a deeper, more intense, and more persistent hyperemia, and an inhibitory influence of different character and capacity, but probably farther reaching under favorable conditions, as when the d'Arsonval current is passed through the tissues between two electrodes, but is deficient in the important heat radiations.

The action and uses of the three forms of radiant energy included, may be summarized as follows:

I. The action of the Roentgen ray upon germ life is inhibitory; probably not directly destructive, but by rendering the microbes inert and checking their propagation, they become an easy prey to the phagocytes. To derive the maximum effect from the x-ray in conjunction with other agents an interval of 12 to 24 hours should intervene, following a massive dose of 10 to 25 minutes according to the volume of radiations. With the ordinary static machine of twelve revolving plates making 400 to 500 revolutions per minute, the exposure for a massive dose should be of 25 minutes duration. Employed in this manner the x-ray adds to the efficiency of the means which induce local hyperemia, in the treatment of infectious conditions.

II. The action of radiant light and heat as previously stated is (1) to induce active hyperemia; (2) to increase local oxidation with the induction of positive chemotaxis, and (3) to inhibit or exhaust walled-in germ processes, while the constant influx of cooled blood into the field through the relaxed walls brings leucocytes fresh for the fray.

III. High frequency currents (1) produce profound local hyperemia; and (2) undoubted actinic and other antiseptic effects adverse to germ life.

In cystitis, and the deeper-seated pus processes, the employment of the x-ray should be persisted in with 10 minute exposures on alternate days until the pus has entirely disappeared from the urine. These observations are based upon a series of clinical results by the writer in the treatment of carbuncles, felonies, furuncles, cystitis, and other septic infections, without an unsatisfactory result during a period of five years.

It can be truly said that in the applications of radiant light and heat, the x-ray, and high frequency currents we possess the greatest means for coping with a large class of infectious conditions, particularly the streptococcal and staphylococcal infections. We have reason to believe that the same rule applies equally to tuberculosis and gonorrhea, and to a greater or less degree in all other types of inflammation arising from infectious causes. It is a subject fraught with the greatest possibilities and deserving immediate serious investigation, and general adoption.

The three agents may be considered congeners in infections, and while each when used alone may succeed in selected cases, their combined use in the treatment of most infected conditions, when skillfully managed, is most effective.

It is impossible to consider the treatment of any class of conditions intelligently with the use of one modality, for though in selected cases it may prove efficient, in others another modality or combination may be required. So in a treatise on radiant energy, or any other subject, when the therapeutics is considered, the indication and use of congeners and antagonists of the agent under consideration should be included.

Otitis media, either the acute or chronic form, is a condition which under the *ancien régime* and even in the hands of many modern otologists has too often been left with the possible paracentesis to the further working of the *vis medicatrix naturæ*.

No greater mistake can be made than to fall into this error, when in the light of known possibilities the condition can *always* be aborted in the early stage and cut short in any stage.

The indication is to inhibit the pyogenic bacteria and destroy them by the induction of an intense local hyperemia in the field of infection.

Treatment.—Radiant light and heat and to a less degree convective heat are eminently successful in meeting both indications. Applications of radiant energy from either the smaller lamps of 50 c. p. are made as near the surface as can be borne, or with lamps of higher c. p. for 15 to 20 minutes or longer if pain is not relieved, every 3 to 12 hours according to severity, the recurrence of pain being the indication for repetition of treatment. When convective heat is employed the heat should be maintained at as high a temperature as can be borne, for

from three to five hours consecutively, and repeated for a like period if there is any recurrence of the pain. Radiant light and heat application is the method to elect, convective heat being only permissible in lieu of the preferred method not being at hand.

In chronic otitis media, frequent short exposures of the x-ray may be made on every second day for ten minutes, alternated with radiant light and heat for half an hour to an hour, or a more approved plan is to make one exposure of the x-ray for 20 minutes, followed after 18 to 24 hours by prolonged intense daily treatments with radiant light and heat until the discharge of pus ceases. Except there are necrotic ossicles this plan of treatment will effect a cure in most chronic cases within three weeks. The additional application of high frequency currents over the mastoid and in front of the tragus will hasten the recovery in severe cases.

Mastoiditis.—The same plan of treatment, including the application of the x-ray as described above, will in the early stage abort this distressing condition, as has been demonstrated in the writer's experience and that of others, as the following cases attest.

Dr. T., dentist, came under observation after having had an otitis media for three months with no sign of abatement. She came under treatment with the consent of the aurist under whose care she had been on account of her desire to go abroad in five weeks, and having no assurance that other treatment would relieve the condition. On the day that she applied for treatment she had forcibly injected water into the middle ear and came the following day with a developed mastoiditis, with pain and marked tenderness over the mastoid, and the outer ear standing out in the characteristic manner. Having employed the x-ray for 20 minutes on the first day, on the next day, when she came with the mastoid involvement, light from a high candle power incandescent lamp was administered for about 30 minutes, until an intense general hyperemia was induced over the region, followed by a 15 minute application of the high frequency current with a glass vacuum tube. This application was made twice daily for three days when the mastoid complication had entirely subsided, improving from the first application. Treatment was continued daily for three weeks in the same manner when the discharge of pus had ceased and she was

pronounced cured by her previous attendant, who by letter commended the method and result, acknowledging that both a mastoiditis and the otitis media had been cured.

The following cases were reported by Dr. Herbert F. Pitcher of Haverhill, Mass.*

"A case of mastoiditis was cured in five treatments. This case, a woman, thirty-six years of age, had been treated a week by the usual remedies before I saw her. She complained of very severe pain in and around the ear and mastoid, with tenderness on pressure and pain on percussion over the mastoid bone. The membrana tympani was red and inflamed, and temperature 100.2° F., without chill.

"Application of strong light was made over the mastoid, in and around ear, side of the face, head, and neck of affected side for fifteen minutes. She returned next day with a report of a good night's rest, but some pain yet. Another application, the same as before, was made. The patient said there was absolutely no pain when she left the office, and there was no pain whatever after that. She received three more applications with complete subsidence of the inflammation, and there has been no trouble since.

"A man, sixty-three years of age, weighing 240 pounds, had the grippe, followed by severe pain in right side of his head and ear for three weeks. The last week the pain was so severe he could neither sleep nor eat. When I saw him he was a wreck. There was a profuse purulent discharge from the ear, the membrana tympani was ruptured, and the typical conditions with the symptoms of acute purulent otitis media. After thorough cleansing of the canal I applied the light for fifteen minutes to the painful side of the head and neck, and into the orifice of the external meatus.

"The patient returned next day saying that he had had the first good night's rest for three weeks. He received six treatments with the result that pain and inflammation have entirely subsided, discharge ceased, and the patient was feeling as well as usual. There has been no return of ear trouble.

"I could enumerate many cases of like conditions and results. It is a source of great satisfaction to me to be able to

*Phototherapy in General Practice, ADVANCED THERAPEUTICS, June, 1906.

relieve and even cure poor suffering humanity of a disease at once so painful and possibly dangerous to the loss of hearing and even life itself.

"I do not contend that it will cure all cases of severe inflammation of the middle ear or where the mastoid has become affected, needing operative relief. But if the light could be used in the early stages it would abort the inflammatory conditions in most cases."

Carbuncles, furuncles, felon, suppurative tonsilitis, and all abscess processes in the early stages are promptly aborted by essentially the same procedures as that employed in the treatment of otitis media, and after evacuation when the presence of fluctuation indicates it, or after evacuation by the natural method, no means is so effective in restoring the conditions to normal and removing all latent infection which might otherwise terminate by extension of infection in a series of abscesses or furuncles, as radiant energy, light, heat, the Roentgen ray and high frequency current systematically employed.

Another method, however, may be indicated in the first 36 hours of pyogenic infections, *i. e.*, to follow a prolonged application of radiant energy with a ten minute administration of direct static vacuum tube current (employing the same connections with the vacuum tube as with the metal electrode with the wave current) directly to the indurated area. By the effect of this method the induration is dissipated and the phagocytes get at the germs and destroy them when the extent of infection is small. The danger of this method is in letting out the infection when the local resistance or phagocytosis is not sufficient to overpower the vicious element, which is small indeed in the early stage.

The results are so uniformly successful by these methods, that in but rare instances, and under exceptional conditions, is failure possible, where the technique is properly carried out.

Tubercular arthritis, treated with the x-ray and high frequency currents in accord with the rationale enunciated, is remarkably relieved. When actual destruction of parts of the joint structure has not taken place, the prognosis from energetic treatment along the lines described, together with liberal judicious diet and approved general régime is good, and the chance of benefit in all cases is assured.

In tubercular adenitis the same régime and general prognosis obtains. The writer's method of treating this affection is to make one massive x-ray exposure to be followed after 24 hours by light and the high-frequency vacuum tube applications. The applications, except the x-ray, should be continued daily until all evidence of infection has disappeared.

Phlebitis.—There is probably no condition in which greater and more prompt relief can be obtained than in early phlebitis by the combined applications of radiant light and heat, followed in each instance by application of the static brush discharge. The writer has cured six cases by this combined method; two in cases of over two weeks' standing, and the others of shorter duration. In each case the veins became patent and the recovery was complete after from three days to two weeks daily treatment. The light from a high c. p. lamp was applied for from 15 to 20 minutes, followed by a thorough application of the brush discharge over the indurated veins.

Pelvic Congestions.—Over various regions of tenderness in the lower abdomen, intense local light and heat radiations afford marked relief and eventually seemingly relieve some internal conditions. This observation is pertinent because it is the experience of many observers that radiant light and heat increase peristalsis, the bowels being frequently stimulated to movement after an energetic administration of light.

Cleaves has also employed light with a specially devised lamp *per vaginam* from which she has reported favorably.*

Orloff of Russia and Makarejev have also reported favorable results from the employment of white light to the pelvic tissues. These observations, while important as showing the possibilities of light therapy, do not equal in point of efficiency the applications of the high frequency and static currents.

Desloges of Montreal reports a case of highly congested left ovary in a neurasthenic treated by 20 minute daily applications of light from a high c. p. incandescent lamp, applied every other day for two weeks when the condition was cured and three months later there had been no relapse.

Curatulo "recommends phototherapeutics as a new therapeutical agent in obstetrics and the diseases of women. He describes a speculum which he has constructed in order to em-

* Cleaves, "Light Energy," p. 55.

ploy the different rays separately and combined. Therapeutic results may be expected in cases of metritis and hypertrophy of the cervix, in cases of badly developed uterus and peri- and para-metritic exudates."*

Ozena is a condition difficult of treatment by light and readily and effectively treated by the direct static and high frequency currents with vacuum tube electrodes, but some writers have reported favorable results from the use of light reflected into the throat and nasal cavities.

Diosurio † reports 16 cases of ozena under treatment with incandescent light reflected into the nose and by introducing a water-jacketed lamp in the nose or a larger lamp in the mouth. In every case he reports a noteworthy "decrease of the waste and secretion, and a disappearance of the characteristic fetor."

Cleaves suggests ‡ the use of the arc light "in treating the nasal, anal, and buccal cavities; with it a profounder influence is obtained, involving greater tissue reaction, when topically applied, by reaction of the complex chemical frequencies."

Post-Operative employment of incandescent light is one of the niceties of modern surgery. Radiant light and heat applied a few hours after an operation for from 10 to 20 minutes will remove to a large extent the diffuse soreness of the tissues, affording the patient great relief. Applied in the same manner over the dressings or better directly to the bared surface, it will promote union and prevent scarring and delayed union. So valuable is this employment of radiant energy, that it should occupy a place as a routine practice in every well ordered hospital, where there is no reason that patients should not have everything conducive to their comfort, and a recovery in the shortest period of time.

Post-Operative Iritis.—A specialist reports following removal of a lens; five days after the operation a severe iritis occurred. "An exudate filled the entire pupillary space, and organized secondary membrane formed; and vision, which was good on the fourth day, was reduced to the barest perception of strong electric light. At first atropin, donin, and local heat were used night and day with little improvement, when an incan-

* Brit. Med. Jour., October 11, 1902.

† Gag. Med. Ital., February 6, 1902.

‡ Cleaves, "Light Energy," pp. 547-550.

descent lamp of high candle power was installed with which the patient was treated every four hours for ten minutes. The relief from pain was prompt, the swelling and discoloration of the iris changed at once, improvement setting in promptly. At the end of two weeks the iris had recovered, and the exudate and secondary membrane had been reduced to the extent that a secondary operation, usually necessary after several weeks, especially following iritis, was undertaken. The operation was successful in opening a beautiful black pupil. As a precautionary measure the lamp was used a few days following the secondary operation, when the patient was discharged with no signs of iritis, secondary cataract, or other untoward result."

CHAPTER VII

RADIANT ENERGY IN DERMATOLOGY

Radiant energy plays an important rôle in the treatment of diseases of the skin, for upon this superficial organ the energy of radiant light and heat are largely expended.

Atonic conditions associated with infiltration or impaired metabolism, or infectious processes are all favorably affected by the employment of radiant light and heat either alone or in conjunction with high potential effleuves, static brush-discharge or vacuum tube applications of high-frequency currents. These measures act by increasing local hyperemia and tissue activity with restoration or increase of elimination, affording the tissues increased nutrition and general functional metabolism and removal of edema or infiltration.

The Roentgen ray in certain infectious processes, followed by radiant light and heat after the requisite degree of inhibition has been effected, is more effective in infectious and malignant conditions of the skin, than the administration of radiant light and heat alone. In some infectious processes, particularly superficial streptococcal or staphylococcal processes, the early employment of radiant light and heat and high-frequency currents will be effective.

The following report of cases and methods will give the best idea for the indication of methods and treatment of various skin diseases.

Varicose ulcers.—The pathological condition resulting in varicose ulcer is one of induration and edema in the skin and subcutaneous tissue in which the parts most remote from the sources of nutrition break down leaving an ulcerated area, which is prone to increase in size as the region of induration widens and becomes more impervious to the circulation.

The indication is plainly (1) to get rid of the induration; (2) to stimulate active local metabolism with hyperemia, and (3) to support the tissues and prevent recurrence.

Treatment.—No agent known to the writer is so energetic in removing the local induration and tissue infiltration as the

static brush-discharge applied daily, following a prolonged application of radiant light and heat. The brush-discharge should be applied each day until the involved tissues are well softened. By this method it is surprising how promptly the process in early cases is healed and with perseverance nearly all cases are ultimately healed.

The supportive treatment consists in the firm application of an elastic bandage over a splint of veneer or stiff paste-board or a perforated metal shield; the surface having been dusted with bismuth subnitrate and covered with a thin layer of gauze over which is placed one thickness of absorbent cotton. After the surface is healed, a firm elastic bandage such as the *crêpe velpeau*, an English production, should be constantly worn and the area daily massaged to prevent recurrence.

Case 1. Miss B., æt. thirty, came under observation, referred by a physician in a neighboring city, with a varicose ulcer which had been increasing in size for more than a year. It was circular in form and about one inch in diameter, surrounded by an indurated area about six inches in diameter, and surrounded by a general edema below the knee. Twenty-minute applications of intense radiant light and heat, followed by a daily energetic application of the static brush-discharge and the employment of a *crêpe velpeau* bandage applied from the toes to above the knee, were made daily.

When treatment was instituted, surrounding the ulcer was a margin about one inch in width of livid degenerated skin on the verge of breaking down, which rendered healing of the ulcer relatively slow. The improvement was prompt and in six weeks the surface had entirely healed, being covered with a normal skin. This patient was then discharged with directions to continue to wear the bandage, and give the limb a daily massage, removing any commencing infiltration or hardening.

Case 2. Mr. McD., æt. 63, came under observation in January, 1908, with an extensive ulceration of practically nine years' duration on the left leg, about midway between the knee and foot.

The open areas were one large ulcer about two inches in diameter and three smaller ones around it, with a tissue area fully four inches in diameter about to break down. The extremity below the area was livid and cold, resembling Raynaud's

disease and the leg from four inches below the knee was infiltrated, cold, and edematous. The second toe was about black, and the nail separating. The extensors of the toes were contracted to the extent that the end of the great toe and the smaller ones, when the patient stood upon them, did not come to within three-quarters of an inch to one inch of the floor. On the left foot one inch forward of the external malleolus was an ulcer about three-quarters of an inch in diameter, and though not so generally edematous, the foot was livid and cold, with the extensors of the toes contracted as on the right leg.

The treatment of this case consisted of the prolonged daily application of radiant light which was manipulated by the patient for from one-half to three-quarters of an hour daily, followed by thorough application of the static brush-discharge which removed the induration daily. The surface of the ulcer, which was inactive and of a venous hue, became active and of an arterial hue after the first treatment, indicating the opening up of the arterial channels to the influx of blood to the margins of the ulcer. The surface was dressed each time, at first with vaseline and later with subnitrate of bismuth, a layer of gauze, a layer of absorbent cotton, a flexible board splint large enough to protect the affected surface, and over all a *crêpe velpeau* bandage extending from toes to knee. The small ulcer on the left foot was healed in two weeks and the improvement in the large one was marked and progressive though slow. Treatment was given daily except Sundays for three months and on alternate days for the following two months, when the ulceration was entirely healed. The second toe and feet resumed normal color within two months. A healthy, normally vigorous nail grew upon the second toe of the right foot, and contractures of the extensor muscles of the feet became relaxed so that within two months the great toe came normally to the level of the foot.

When treatment was begun the patient, who for months had been seated in his room with his foot elevated, came once in a cab and afterwards by the street car, being rendered comfortable and relatively free from pain at once on the institution of treatment. This patient had been in the best hands on two continents for five years, during which time all previously recognized methods had failed, marking it as one of unusual severity.



Plate V.—Method of Treatment with the London Hospital Lamp.

Suppurating Ulcer.—Dr. J. A. Mohnson reports the following case: Male, æt. forty-five, who in November, 1904, ran a barbed wire into his elbow, which was neglected, resulting in a chronic infection. In September, 1905, there were seven suppurating ulcers with thickened edges, covering a surface six inches long by four broad. The whole surface was tender and indurated and of a bluish color. The condition was treated with a 500 c.p. incandescent lamp, exposures twenty to thirty minutes each, the lamp brought down as close as it could be borne, with an occasional "hot one" within a few inches of the affected surface. In all seventeen treatments were given. All of the ulcers were healed though considerable induration remained.

Lupus and Allied Conditions.—“Rieder of Munich says that in order to utilize electric arc light for therapeutic purposes in skin affections, it must be more concentrated, than from a reflector. This was first overcome by Finsen (1893). Strong currents and concentration of the light by quartz lenses as well as elimination of the heat rays are necessary for an intense effect of the arc light.

“There has always been a tendency to create new light sources, apt to produce more chemical rays than the old sources do. But only the so-called iron lamps have been of any account. The rays of the iron light have a strong irritating and bactericidal effect, combined with moderate heat-radiation, but they possess very little of the quality of penetration. Therefore deep-seated affections of the skin—for instance, lupus—are not affected by this light. On superficial diseases it is very effective.

“The question, whether the heat rays are of use in curing skin diseases, is nowadays generally answered in the affirmative, but Rieder is skeptical and points to the Finsen method which is of cold light; for behind the water-cooled compression-lenses, there is nevertheless heat produced. This light seems to be a lucky combination of light and heat rays.

“It is absolutely necessary to produce a slight reaction in the skin before beneficial results may be expected. There are four stages of reaction; hyperemia of the skin, painful blistering, superficial ulceration, necrosis with the formation of ulcers.”*

* Wiener med. Presse, 44, 1903, pp. 2074, 79.

" Morris and Dove compare their results in the light treatment in lupus and other diseases of the skin with those of Finsen. Finsen gives in lupus 94 per cent. and in epithelioma 50 per cent. cures. The results of Morris and Dove are not so favorable. From 65 cases of lupus in treatment 11 remained for two years without recurrence. Improvement took place even in the worst cases. They used for the skin the Finsen lamp and for mucous membrane Roentgen rays. In 11 cases of lupus erythematosus 7 remarkable improvements were recorded. In 27 cases they improved very well. Two cases of alopecia did not improve. Patients should be kept under observation for at least three years."*

" Moller of Stockholm reports results of phototherapeutic treatments at the St. Goran Hospital. Up to April, 1904, were treated 113 cases; 79 cases of lupus vulgaris, 17 lupus erythematosus, 12 carcinoma cutis, 3 alopecia areata, 1 nevus vasculosus, 1 acne rosacea. In the lupus cases light treatment proved to excel all other methods. Of the 32 completed treatments 17 cases were cured, 10 almost cured, 4 improved, 1 hardly influenced. The treatment was either pure light treatment or it was assisted by the application of salves or galvano-caustic puncture, removal of tuberculous glands, etc. In cases of lupus erythematosus the infiltrated forms reacted well, while the superficial ones showed no results. Of 12 cases of skin carcinoma, 7 were cured. Two cases of alopecia areata were cured."†

" Schaltz of Berlin contends that in treating lupus vulgaris with chemical rays the heat rays play a conspicuous part. If, for instance, on an agar-layer is placed a Finsen cooler and through this is illuminated with a concentrated electric arc lamp, the agar-layer will melt on the back-side, but not on the side exposed to the light source. From this and other experiments the author concludes, that the cooling of the skin is only superficial and that the heat is in action in the deeper layers."‡

" Lesser of Berlin reports on the light treatment of skin diseases after the Finsen method and says that two qualities of the light are to be considered, i. e., the tissue-destroying and hereby

* Practitioner, 1903, April.

† Norcisk medicinsk Arkiv., 1904, No. 10.

‡ Berl. klin. Woch., 1904, No. 18.

inflammation-causing quality and, secondly, the bactericidal quality of light. In fact, those two qualities are combined in one and the same process when certain light rays destroy a cell in the human body or when they kill bacteria, as each micro-organism is nothing else than a living cell. The more a method is destroying the affected without attacking the healthy cell the more it is nearing the ideal requirement. At the University of Berlin are used Finsen apparatus of 30-40,000 candle power (48-50 volts, 70-80 amperes) mostly in the treatment of lupus cases, and although the exact results are not yet available, the superiority of this method over others is established."*

"Teredde reports the results from phototherapy in 11 rebellious cases of lupus erythematosus of the face. Of these 3 were cured, 2 were benefited to a marked degree and passed from under treatment. Of the 6 patients remaining 4 were being cured and 2 showed no improvement. He regards this method of treatment the best for grave forms of the disease."†

"Schamberg of Philadelphia gives his results in treatment of various diseases by Finsen light and Roentgen rays.

"1. Finsen light is beneficial in the treatment of lupus vulgaris; but large lamps are required.

"2. In lupus erythematosus Finsen light effected some improvement but no cures.

"3. In certain cases of lupus vulgaris (ulcerated nodules, when mucous membrane of nose, lips, or mouth is affected) the Roentgen rays are preferable.

"4. The Roentgen rays have certain distinct limitations in the treatment of cancer of the skin, when not deep-seated.

"5. Roentgen rays are very valuable in acne.

"6. Roentgen rays are valuable in eczema.

"7. Roentgen rays have proved beneficial in sycosis, lichen, planus, hypertrichosis, ringworm, and favus of hairy regions, tuberculosis of the skin, mycosis fungoides, etc."‡

"Pick and Asahi of Prague have treated after the method of Tappeiner and Jesionek 12 cases of lupus, 2 cases of tuberculosis cutis verrucosa and ulcus rodens, 5 cases of trichophytosis and 3 cases of scrofuloderma. The affected parts were in the morning brushed with one per cent. solution of eosin in a

* Zeit. f. Diat. & Phys. Ther., Vol. 5, 1902, pp. 449-457.

† Bul. Gén. de Thérap., January 23, 1901.

‡ American Medicine, December 19, 1903.

physiological salt solution. During the day these parts were repeatedly moistened with a salt solution in order to avoid drying in, and as much as possible exposed to the sun; over night the parts were covered with an indifferent salve bandage. The results were in 11 cases very encouraging. In cases of lupus the inflammatory infiltrations receded and the process of cicatrization made fast progress; the cases of trichophytosis healed in a few days."*

Eczema treated by radiant energy is generally effective and in other cases it adds greatly to the efficiency of local applications. No agent is so efficient in the writer's experience as the local application of the static brush-discharge for removing the local induration or infiltration of eczema either alone or following local applications of radiant light and heat; and when persisted in, it is generally effective. Excellent results have been effected by numerous observers from the use of radiant light and heat.

"Winternitz of Vienna claims to have proved conclusively that the effects of sun and electric light are not simply of thermal character. For example, the elimination of the chemical rays with a transparent red material is sufficient to make the high temperature in an electric bath endurable. This phenomenon induced Winternitz when applying sun baths to cover the part of the body which was exposed to the sun, or the whole body, with red cloth. The results of this measure were diminution of chronic skin hyperemia, anemization of hyperemic portions of the skin, improvement and cure of eczema."†

Desloges reports a case of eczema of eight years' standing covering much of the body to which for several weeks high-frequency currents were applied to the hands with success. To the eruption still remaining on the legs and surface of the body generally the high candle power incandescent lamp was applied. The redness gradually disappeared and the scars separated, leaving the skin clear and in a normal condition after three weeks. The applications were made for twenty minutes morning and evening. Two years later there had been no recurrence.

Eczema, moist, of hands.—Dr. Walter of Kramer, Ind.,

* Centr. f. d. med. Wissensch., 43, 1905, p. 158.

† Bericht. u. d. 22 off. Versam'l dr. Balneol. Gessellsch. Zu Berlin, 7-21 Murz, 1901.

reports a case in a man of fifty years. First attack involving hands and wrists with severe itching and exudation of serum from cracks and fissures made no improvement from wearing gloves and using various ointments, not washing during six weeks' treatment. After two weeks' treatment with the leucodescent lamp every night he made a complete recovery. Improvement was noted from the seventh treatment. This case had had treatment from able dermatologists.

Psoriasis.—Dr. Walter of Kramer, Ind., reports over thirty cases of psoriasis cleared up during two years with the high candle power incandescent lamp. He states that results begin to show in from ten to twenty daily treatments, and that thirty to forty treatments extended over a period of six weeks should be given, taking an hour for each treatment when the entire body requires treatment. Under this plan he states that spots clear up in the center and become more pink and then fade away. Subsequent treatments when small spots return will keep it from reappearing.

He emphasizes the statement that if cases are treated for from six to eight weeks making exposures of from fifteen to thirty minutes to each part, cases of psoriasis will completely respond. These statements are made from an experience with from thirty to fifty cases during three years in an institution where such cases congregate.

Steiner of Leipzig reports results in electric light treatment. He used concentrated arc light in cases of furunculosis and sycosis barbæ, no benefit. In cases of psoriasis, the results were doubtful. Cases of scabies were cured with three applications. Pityriasis versicolor disappeared after five applications. Prurigo ceased after two baths. Grave cases of impetigo were cured with eight baths. Very grave cases of chronic dermatitis were cured after seventeen applications. Cases of seborrheic eczema were cured after four baths. Chronic eczema was cured. Steiner gives the clinical history of thirty-two cases confirming his claims.*

Dr. Charles R. Dickson † refers to the use of the iron arc ultra-violet lamp in the treatment of a number of conditions,

* *Munich med. Woch.*, 52, 1905, pp. 748-51.

† "Some Aspects of Phototherapy," *Journal of Advanced Therapeutics*, January, 1905.

maintaining that while the penetration is slight, it fills a place of its own in the therapeutics of certain skin conditions.

"The ultra-violet rays," he states, "have a marked analgesic action. This was very clearly manifested in an extensive, inoperable epithelioma of the lower lip recurrent after excision, in a man aged 57 years. The case was really too far gone for any raying, but it was rayed in the hope of retarding somewhat the progress of the disease. In spite of all that was done, the tissues were breaking down extensively and there was much pain in the lip. Ultra-violet rays being used as an alternative, relieved this pain so that the patient dropped off to sleep a few minutes after the first time they were employed, and there never was severe pain thereafter."

"Superficial neuralgias are often speedily relieved by ultra-violet rays, as is also the itching of epithelial neoplasms, benign as well as malignant.

"The atonic action of the iron arc rays may be observed readily when they are employed to promote rapid healing of superficial abrasions, for instance, on the hands or fingers of surgeons where dressings are very inconvenient, and an abraded epidermis is a constant menace to safety. In such cases it is rarely necessary to repeat an exposure of ten minutes. All signs of inflammation, if present, will usually have passed away by the following morning, or in the course of a few hours after raying."

He also treats of the employment of the ultra-violet rays in the treatment of seborrheic eczema, in which after prolonged treatment no permanent result was obtained. In *lupus erythematosus* some benefit was obtained. A case of *acne rosacea* on the nose of a young lady, was practically cured after 29 treatments. He also reported its employment in *acne vulgaris*, *chronic eczema*, and *varicose ulcers*, with variable results. Dickson further states that the bactericidal action of the iron arc rays is well marked in *sycosis*, in the treatment of which adrenalin chloride is used in connection with the employment of the rays from the iron arc lamp, the lamp being held about an inch away from the hairs. Five treatments of ten minutes each effectually removed the condition in ten days.

Another evidence of the bactericidal action of the rays reported by Dickson, was in the treatment of a furuncle on the neck of a boy 12 years of age. The treatment was made fol-

lowing adrenalin chloride applied to render the tissues anemic. The swelling was remarkably diminished and after the second raying of ten minutes, one day intervening, the furuncle had disappeared.

Excellent results were also quoted in the early treatment of *carbuncles* and also in the ulcerated surfaces following the opening of the abscess. The effects of these rays, the writer states, are efficacious in superficial lupus.

CHAPTER VIII

RADIANT LIGHT AND HEAT IN THE TREATMENT OF CONDITIONS ASSOCIATED WITH FAULTY METABOLISM

The stimulating and tonic effects of radiant light and heat upon general metabolism are due to several specific actions or effects induced on the tissues in the circulating fluids of the body.

I. The actions on the blood. (1) The oxidizing influences of radiant light and heat favor to a remarkable degree active tissue metabolism. (2) The oxygen carrying function of the blood is enriched by an increased percentage of hemoglobin due to the direct action of light rays, and (3), the lymphatics are rendered more active in eliminating waste products and toxins by the sweat glands and other emunctories of the body.

II. The superficial end organs are stimulated to a greater activity with an increased tissue change, both anabolic and catabolic.

III. The deep spinal centers are reflexly stimulated to greater reflex activity by the intense effects of the applications of radiant light and heat to the peripheral neurons, thereby arousing greater general activity of the vital centers, particularly the perspiratory, cardiac, and excretory centers.

IV. The general diffusion of heat which takes place by convection from the blood heated at the periphery, promotes general tissue oxidation and elimination throughout the organism.

V. The actinic and thermic action of the radiant light and heat upon the germs in local areas of infection, causes inhibition of activity and destruction of the germs by the phagocytes, thereby relieving the tissues generally from the toxic materials otherwise thrown out.

VI. The induction of superficial hyperemia, local or general, promotes nutrition in the tissues by an increase of nutritious pabulum distributed through the tissues, as well as an increase in the number of nature's scavengers, the phagocytes,

where hyperemia exists, thereby increasing the general tissue resistance, as well as awaking a greater metabolic activity.

VII. The stimulation of increased elimination through the sweat glands and other emunctories, induces the removal from the system of the poisonous toxins which vitiate the general system and cause general impairment of metabolism.

The actions thus instituted by the systematic employment of radiant light and heat, it will be readily seen, are most valuable; because, when administered in a technically scientific manner with the requisite attention to details of administration, they favor the elimination of waste materials, and the increased activity of general and local metabolism with marked increase of oxidation and tissue combustion, generally favorable to the establishment of the normal functions of the body. The increase of superficial hyperemia not only influences the institution of increased local tissue resistance, but in conditions of impaired kidney functions and arteriosclerosis, relieves arterial tension and facilitates the elimination of the waste products through the skin, which the impaired kidneys are unable to eliminate.

In all forms of nephritis, radiant light and heat are indicated, and offer probably greater aid in relieving the system loaded with nitrogenous waste products than other therapeutic measures. *In parenchymatous nephritis*, particularly, radiant light and heat afford a remarkable means of relief. Cases which have failed to yield to medicinal or other physical treatment, when placed under the systematic employment of radiant light and heat, have been effectually relieved and cured. The treatment of parenchymatous nephritis by radiant light and heat should be carried out under a thorough régime. The full light baths should be given daily for periods of 20 to 30 minutes, preferably with the patient reclining in the bath cabinet. A greater degree of diaphoresis is induced in the cabinet owing to the accumulation of convective heat. Diaphoresis is not the chief indication conserved, but favors the elimination of a larger quantity of nitrogenous products through the skin. The reflex effect of the heated blood upon the spinal centers favors the relief of general tension and engorgement, and promotes the restoration of the normal function of the kidneys. The added employment of the static wave current over the kidneys further favors the relief of local engorgement.

The elimination of toxins, often the active cause of parenchymatous nephritis, as present following diphtheria, nephritis, and other infectious conditions, favors the restoration of the kidney function, and also relieves other parts of the organism, unfavorably affected by the presence of toxic material in the fluids and sluggish recesses of the body as often occurs following attacks of local infection, when it would seem that the phagocytes engorged with the pyogenic bacteria, had become lodged in the regions of imperfect circulation as in the joints, setting up a local inflammatory process as present in various types of infectious arthritis.

Infectious arthritis or so-called rheumatism, and conditions which have been considered as allied to rheumatism, are undoubtedly due to the influences of toxic infection arising from some active site of germ proliferation either present in the alimentary canal, or elsewhere in the tissues, as in the seminal vesicles in cases of gonorrhreal arthritis. The older notion that germs themselves were locally present and affecting the local inflammatory processes, seems to have been generally disproved.

With the above premises accepted, it is evident that the first indication is to stop the pyogenic or other bactericidal process either by the induction of local hyperemia, by means of an increase of local phagocytosis, or by the employment of intestinal or other local antiseptic measures to destroy the germ *in situ*. Another indication is to promote as rapidly as possible the elimination of the toxins from every part of the body, which is best effected either by the use of a general light bath with as high a temperature as can be borne, or the employment of the body dry hot air bath. That the light bath possesses a greater energy than dry heat in the treatment of general infection, is probably due to the fact that the actinic action of light upon the blood is added to the thermic effects. Furthermore, the light radiated upon the surface of the body, as explained elsewhere in this volume, penetrates to stimulate tissues to greater depth than with the application of convective heat alone; whereas, with the radiant light and heat bath cabinet both radiant light and heat, and convective heat, influence by stimulation of the emunctories the elimination of waste products. The only advantage that can be demonstrated of convective heat applications, is from the fact that the body



Plate VI.—Reclining Light Bath as Used by the Author and Associate.



wrapped in Turkish toweling which takes up the moisture which congeals upon the surface, will stand a degree of temperature above the boiling point without blistering the surface of the body, as is certain to occur if too high temperatures are otherwise employed.

The general indications are practically the same where a general toxemia exists with a tendency to an involvement of joint or other structures in remote parts of the body; whereas, in cases of local septic infection, as stated elsewhere, the local employment of convective heat seems the most practical means of effecting the destruction of the infection (see convective heat in septic infection on page 98).

In arteriosclerosis two important points for consideration are present: (1) the correction of those conditions or habits of life and diet which lead to toxemia; conditions which seem to superinduce arterial hypertension, and (2) the elimination of toxic materials which are retained in the system.

Dr. T. D. Crothers called attention to the importance of radiant light and heat in the treatment of arteriosclerosis in a paper published in 1905,* in which he stated that "frequently the use of drink and drugs are symptoms as well as causes of those pathological conditions. Always associated with it are toxic states with defective elimination, local congestion, and palsies of the vaso-motor nerve, and with defective nutrition and elimination, there is starvation and poisoning.

"The radiant light bath by this specific sudorific action, appears to have a marvelous effect on the elimination of the toxins, and the stimulation of the vaso-motor centers also influences metabolism."

He quotes cases in which he has demonstrated beyond question the efficacy of the radiant light bath in the treatment of arteriosclerosis. In another paper published in the Journal of Advanced Therapeutics for December, 1906, "in control experiments with healthy patients, the tension is generally lowered. . . . In a person with high arterial tension and a regular heart action, together with the static breeze, radiant light and the shower after, there is a falling of the tension and an improvement of the action of the heart."

Experiments made by the writer in conditions of high arte-

* Radiant Light Bath in Arteriosclerosis, Advanced Therapeutics, August, 1905.

rial tension, have demonstrated a uniform fall of from 5 to 10 mm. with the modified Riva Rocci sphygmomanometer, from a prolonged application of radiant light and heat from a 500 c.p. incandescent lamp, which effect is undoubtedly due to two influences—to capillary dilatation of the smaller superficial arterioles and capillaries, and the relief of the system from a certain amount of toxic materials with perspiration.

The treatment of arteriosclerosis should not be confined to the employment of light, as the regulation of diet, and the use also of high frequency auto-condensation, the last of which promotes a large degree of tissue combustion and elimination, play an important rôle in the treatment of this condition. If taken early in hand by careful attention to habit and régime, arteriosclerosis can be effectually controlled and prevented in most cases. The employment of light in these cases, however, should always constitute a part of a well regulated régime in the treatment of arteriosclerosis. All conditions associated with impaired nutrition, as *anemia, leukemia, pernicious anemia, leucocythemia, rheumatoid arthritis, peripheral defects of metabolism associated with spinal cord affections*, and the *functional neuroses*, in all of which conditions there is a lessening of the local resistance of the tissues with a relative degree of defective local or general metabolism, are always benefited by any agency which will stimulate an increased blood supply co-incident with increase or stimulation of end-organ metabolism. It is therefore a matter of much importance in the general recognition of the advantages of these important therapeutic agencies, that they should be appreciated in the treatment of all conditions associated with impaired metabolism, local or general. This systematic employment, in conjunction with other physical methods and dietetic regulation, is indicated in all such cases. So important is the employment of radiant light and heat as a daily régime in the management of these cases, that its employment is certain to become a general routine practice as important as the shower bath in the home under the direction of the family physician. The light bath must become in the well regulated household of all those who can afford it, a part of the daily life régime for those who are suffering from impaired metabolism or would employ it as a prophylactic against the inroads of disease.

It is an undoubted fact that the business man or woman and the housewife who are confined within a home or office during the larger part of the day, and who when in the open are clothed in thick garments opaque to light, fail to receive the requisite amount of sunlight to properly maintain a normal physical status. For this reason the general use for a short time daily of the electric light bath in the home, should be encouraged. It should be adopted as a prophylactic measure, or for the relief of conditions of impaired metabolism, but should not preclude the necessity of the regulation of other hygienic measures, particularly, careful attention to the diet of the individual.

Until such time as the community shall be educated to the importance of these things, the profession must employ radiant light and heat in the treatment of many of their cases; for it will not be possible, in the face of the importance of these measures, to conscientiously manage the treatment of diseased conditions in which the indication for the employment of radiant light and heat is so apparent without either the institution of the means in the practitioners' office, or their direction to their patients to go elsewhere.

CHAPTER IX

OPPOSITE EFFECTS OF RADIANT LIGHT AND HEAT AND THE ROENTGEN RAY

The study of the different forms of radiant energy reveals a variety of action and effect which indicates a diversity of application to therapeutics. The relation of the frequency of vibration to penetration, the degree of penetration, diminishing as the frequencies increase, until the higher frequencies of the Roentgen ray are reached, regulates the therapeutic indications.

"It was predicted by Helmholtz, the great mathematician," says Sir Oliver Lodge, "that if waves could exist still smaller, you would ultimately get waves smaller than the atoms, and that then, instead of being bent more, would be bent less; and in that way we should have the upper part of the spectrum with dispersion reversed—the spectrum at last folding back upon itself, until, you come to the ultimately small waves, they would not be bent at all, but would go straight on. The prediction was fulfilled in the x-ray, which is not refracted, but goes straight on, and is constituted of the shortest wave-lengths, excessively rapid, and waves smaller than anything conceived before. Fulfilling the theory of Helmholtz these rays go straight on."

It was observed by the writer in a paper published by him,* that a remarkable contrast exists between the ultra-violet and the x-ray. The latter, of varying wave-lengths, are not sorted out from one another—are not refracted, but go straight on without any deviation whatever.

Sir Oliver Lodge describes the x-ray as follows: "It is simply a solitary wave, a solitary pulse, up and down almost instantaneously, and no more; nothing continuous, not a succession of waves—a solitary pulse, one splash like a whip-crack, just again and again. With every blow of an electron the derived x-rays proceed from the target in very rapid succession, in all these flashes or cracks, because the electrons or cathode rays are bombarding the target in very large numbers."

* "Comparison of Forms of Radiant Energy," Archives of the Roentgen Ray for December, 1906.

It will be readily seen, therefore, that the characteristics of the Roentgen ray differ materially from those of radiant light and heat radiations, both as to wave-length and the method of discharge or irradiation, which from a physical point of view accounts for their different action upon the tissues. The effect must be looked at also from another point of view with reference to their impingement or absorption by the tissues. In the matter of radiant light and heat rays, they do not pass through dense and deep tissues, their energy being spent, when they have each passed to depths relative to their wave lengths. While the penetrations, particularly the lower frequencies, are considerable, they are generally absorbed before passing through the body upon which they impinge, while the x-rays pass through. It must also be taken into consideration that the density, or volume, of these radiations from the usual sources of radiant light and heat is very much greater than from the usual sources of the x-ray. The heat effect, therefore, of the forms of radiant light and heat, is pronounced whereas a large percentage of the radiations from a modified Crookes tube pass directly through the tissues producing relatively little, if any heat from the effects of absorption, or spent energy. Another factor must be taken into account with reference to these radiations—the effect of passing through the tissues in the interspaces between the cells, as suggested by Helmholtz, and confirmed by Sir Oliver Lodge, would be liable to produce an effect upon the cell bodies; because the other ethereal vibrations, as evidenced by the effects of radiant light and heat, possess an energy within themselves, capable of affecting cell protoplasm. It is probable, on account of the intense rapid vibration of the penetrating Roentgen rays, that they profoundly affect cell protoplasm, as first observed in a previous work of the writer * in which the Physiological Effects of the Roentgen ray were considered as follows:

“The study of the actions of the x-ray is the study of the effects of a form of vibration—agitation of the ether of the highest recognized intensity. It is an invisible force, and, like other invisible forms of vibration, can only be comprehended by the effects arising from its actions.

“The *physical characteristics* are as follows:

* “Static Electricity and the Uses of the Roentgen Ray,” p. 220.

“ I. They penetrate many substances which absorb the visible rays of the spectrum.

“ II. They are refracted * when passing from one medium to another of different density, but very slightly.

“ III. They are but slightly reflected, and are absorbed by substances which they do not penetrate, and cause others to fluoresce.

“ IV. What the peculiar effects of the rays may be upon the protoplasmic structures of the body as they pass through the tissues can only be determined from the conditions arising, which are as follows:

“ (1) As one stands before the radiating tube with the rays penetrating the body, there is little perceptible sensation. It may have been noticed, however, if the hand be held before the tube for several minutes that a sensation of gentle contraction of the skin is perceptible. The statement of this fact is not uncommonly made by patients under treatment by the x-ray, and it is so from the writer's personal observation.

“ (2) It is also observed that the surface of an ulcerating cancerous growth appears as if glazed or as covered with a thin coating of collodion after an exposure of several minutes.

“ (3) The substance of a growth, when standing prominently above the surrounding surfaces, is also perceptibly contracted.

“ (4) Following a series of exposures it has been observed by all familiar with the subject that the skin becomes atrophied, and the hair follicles and sweat glands become inactive—hair falling out and secretion of sweat ceasing.

“ (5) Pain is in most cases relieved to a remarkable extent after a few exposures in various inflammatory and malignant conditions.

“ (6) Congestion is evidently diminished, as is indicated by the relief of conditions which could be explained under no other hypothesis, occurring, as it does, when inflammatory conditions are exposed to the influence of the rays.

“ (7) Long or repeated short exposures produce dermatitis and necrosis, deep or superficial, according to the length of exposure.

“ The above propositions, jointly and severally, point strongly

* Recent convincing reports affirm that the x-rays are slightly refracted, contrary to Roentgen's first statement.

to one effect in particular, which accounts for all—*the contraction of cell protoplasm*. The sense of contraction of the normal skin, the glazing and contraction of an ulcerated surface, the atrophy of the skin, and the relief of pain and congestion are all indicative of tissue contraction. Indeed, it is the most plausible explanation of the impaired nutrition, for necrotic and sloughing tissue, normal or diseased, betokens a diminished blood supply—local anemia; due as a consequence of the contraction of the muscular coats of the vascular system. Whether the action is the influence upon the end plate of the neurons or upon the individual cells it would be difficult to assert; but the latter is most probable.”

The writer in a former contribution * presented a statement of the results of the action based upon clinical observation: “That the effects of the x-ray upon the normal tissue are (1) to induce normal activities, due to the vibratory effect of the rays, or of the ether in the presence of the rays. (2) That these effects with short exposures at proper distances with high vacuum tubes induce activity of normal tissue cells, which, in some cases, supplant abnormal tissue elements without evidences of disintegration. (3) That exposures destroy only the abnormal tissues unless they be too prolonged. (4) That abnormal tissue thus exposed breaks down and disappears through the natural channels of absorption or by sloughing.” It has been shown in the writer’s experience that tissues of low vitality are always the first to break down.

“It is probable that the vitality of all tissue is lowered by cutting off the blood supply as well as by inhibition induced in the cells. *Naturally*, under such circumstances, tissues of low vitality are the *first* to break down. It is also well established that the tissues of debilitated patients do not resist the destructive action of the rays as do those of normal individuals, which confirms the theory.

“It has also been demonstrated that malignant tumors in the aged or infirm are more likely to soften and break down than in normal individuals, which confirms the view that when, for any reason, the tissue resistance is lowered the tissues break down. The violent toxemia occurring under such conditions is

* “The Uses of the X-ray and Accessory Measures in the Treatment of Diseases of the Skin,” JOURNAL OF ADVANCED THERAPEUTICS, June, 1903.

not due to extension of the malignant process, but to the auto-infection arising from absorption of toxins present in the broken-down structures.

"This effect upon circulation and nutrition when employed to the extent of destroying malignant growths is at best a dangerous one, and demands careful attention to the management of details and a knowledge of their consequences.

"*The cumulative action* is a striking feature of the effects of the rays and demonstrates the more or less persistent condition of contraction which follows a series of exposures and explains the diminished metabolism after long exposures or series of exposures.

"It would seem, therefore, that the logical explanation of the action of the x-ray when nearby, prolonged, or frequent administrations are given is, that the exposed structures contract at the expense of nutrition and produce, when carried to a certain degree, necrosis of the part. This theory accords with the therapeutic results obtained from nearby and prolonged exposures.

"*The stimulating or tonic effect* of the Roentgen ray, induced by short exposures or with a high-vacuum tube at distances of sixteen to twenty inches from the anti-cathode, is probably due to the disposition of the vibratory influences of the rays both to overcome local stasis, restoring tone to the muscular coats of the arterioles, and at the same time to induce a more active local metabolism.

"A knowledge of the action of all stimulants teaches that their employment must be judicious or the opposite effects will result. So with the x-ray, to obtain the tonic action, exposures must be infrequent (not oftener than twice weekly), with penetrating rays emanating from a tube usually at a distance of from twelve to twenty inches. The length of exposures under these circumstances may be for the usual period of ten minutes."

The inhibitory actions from prolonged exposures are effects, which we are considering as antagonistic to the stimulating effects of radiant light and heat from short or prolonged exposures. The stimulating effects of the Roentgen ray as referred to are not generally employed for the reason that the other forms of radiant energy best conserve that purpose. These views expressed by the writer in 1904 have been in the experience of many observers verified; and while to the present

time no other definite physiological effects have been published, the general consensus of opinion is drawing to the recognition of the part contraction of protoplasm plays.

Since these observations were made, it has been further demonstrated that the tissue inertia induced from the inhibitory action of the Roentgen ray, points to another very significant effect, which is likewise best explained by the condition of tissue inertia following the profound effects upon protoplasm, in response to the intense vibratory influence of the penetrating rays; that is, the effect upon the procreative functions in mammals as well as in the lower forms of germ life. This fact was referred to by the writer in an editorial* on "The Actions of the X-ray upon Animal Tissues," as follows:

"The physical characteristics of the x-ray, as generally accepted by physicists, precludes the acceptance of the idea of ionization or that the rays possess any electrical qualities, except peculiar characteristics which can be derived from no other source. They are lines of longitudinal ether vibration (not Hertzian waves) transmitted in straight lines from a source of great energy, possessing qualities whereby they penetrate solid bodies indicating an expenditure of the energy derived, which may be either entirely spent upon bodies of too great density or absorbed in varying degrees in their passage through objects of different densities. Under the laws of conservation of energy when projected against animal tissue this force is spent upon the tissues, exerting characteristic influences—the effects of the x-ray.

"There are three hypotheses upon which the results of these exposures which are so little appreciated by the profession to-day, might be explained. (1) It is probable that cell protoplasm is affected by the stimulating action of these energetic lines of vibration to a state of contraction that suspends activity in varying degrees depending upon the duration, frequency, or intensity of the exposures. Under this hypothesis nutritive processes would be suspended by lessening or discontinuance of the metabolic processes and at the same time by diminishing or cutting off the local blood supply owing to the contraction of the cells which comprise the muscular coats of the arteries. In this connection it is a well authenticated fact that the action

* ADVANCED THERAPEUTICS, March, 1905.

of the ray is cumulative, that the extreme degree of physiological effect is not reached except the exposure is prolonged or of great volume or intensity, or at the termination of a series of exposures.

"(2) It is possible that only the neurons are stimulated resulting in the effects upon metabolism and the circulation as above described. It is doubtful, however, if such stimuli would only affect the vasomotors.

"(3) It would be tenable and account for most of the results that the effects are induced by the contraction of muscular cells.

"The former hypothesis is the most probable because it better explains the various actions of this remarkable agent. It is the induction of cell contraction with the effects of suspension of animation, of activity, of function, of metabolism. These results would obtain from the effect upon protoplasm above suggested, and seem to explain every consequent action of the rays upon animal tissue.

"It will be observed by those familiar with the x-ray that the bulk of a superficial tumor exposed to the x-ray will be appreciably contracted after an exposure; that a surface moist and discharging will be covered as by a glazing or coating as of collodion after a ten minutes' exposure; that the skin becomes thinned and atrophied after a series of exposures, that a so-called dermatitis occurs. An x-ray dermatitis is not analogous to an inflammatory process but to the commencing stage of necrosis, to be followed, if persisted in, by a type of necrosis occurring from no other source. When exposures are made to an unprotected surface with sufficient energy to produce tissue necrosis a striking evidence is presented of the varying degree of intensity relative to the distance from the central point of exposure over the convex surface nearest the source, and of greatest intensity—the part closest to the rays will be necrotic, and between the center of the exposed field and the margin where normal skin is present all shades of vitality will be induced from without inward. This fact explains the tedious process toward recovery after one of these serious mishaps.

"The effects upon the various organic structures of the body are in full accord with the first hypothesis. The effects of the ray in leukemia while they seem to be beneficent, by diminishing the enlargement of the glandular structures, have been

shown from a long series of cases to produce only temporary alteration in the character of blood, while in the end, the patient dies. It would seem in this instance that the ray was interfering with a beneficent provision of nature.

"In hyperidrosis pedis by a few x-ray exposures, the activity of secretion is abated. It has been shown by many observers that enlarged thyroids may be reduced in size by a series of exposures, but no evidence of complete suspension of function has been presented. The effect upon the absorbents, as is demonstrated by prolonged exposures over the abdomen, is to lessen the functional activity with marked decrease of body weight. The effect upon all tissues the habitat of germ processes is to destroy or diminish the activity of the germ by rendering the abode unsuitable. The effect upon glandular structures is to produce inactivity, as stated previously. The processes of ovulation, fetal development and the function of the seminal vesicles may be seriously impaired or suspended, the degree of interference depending upon the extent of the exposure. These functions, except a possible termination of pregnancy, will resume normal conditions in a few months after the cessation of exposure. In all cases these results are evidences of suspension of nutrition or activity arising from contraction of the cell."

The experiments of Dr. Edward C. Titus, as published * further demonstrate the inhibitory action of the Roentgen ray upon germ processes, as well as upon the germinal spot in eggs and seeds.

"Being greatly interested in these investigations, I made a series of experiments to which I will now briefly refer.

"I took a definite quantity of various seeds, such as bird seed, lentils, peas, beans, and oats, and planted one portion of them in soil and another portion in wet cotton in order to determine whether they would grow.

"Having convinced myself of this I then subjected another portion of the seeds from the same supply to the action of the x-rays, then sowed them under the same conditions, and now found that no growth took place. When, however, some of

* "Relative Action of the Roentgen Ray and Light upon the Enzymes, and Their Therapeutic Significance," JOURNAL OF ADVANCED THERAPEUTICS, November, 1905.

these rayed seeds were exposed to the parallel rays of a marine searchlight and afterwards planted, they began to sprout, but not as vigorously as in the control experiment. My next experiment was made with fresh hen's eggs procured from a reliable dealer; these were divided into three lots. Of these one dozen were placed in an incubator and after three weeks nine were found to have been hatched. The next two lots of one dozen each were subjected to prolonged exposure to the x-rays and of these one dozen were placed at once in the incubator and the remainder first submitted to the action of the searchlight before doing so. The two dozen which had been rayed were left in the incubator for four weeks, and when removed it was found that those which had not been exposed to the light had undergone no evolution whatever, while those which had, showed different stages of embryonic development."

These results, together with experiments by the writer during the summer of 1904, led to the conclusion that from these two forms of radiant energy—radiant light and heat and the Roentgen ray—there were distinctly opposite effects; the stimulating effects of the former, and the inhibitory effects of the latter, each diametrically opposed to the other. In an editorial in that year, the writer had called attention to the fact as follows:

"One year's experience in the employment of a thirty-five ampere arc light, projecting parallel rays from a parabolic mirror, as provided in a marine searchlight, has demonstrated its great value in preventing x-ray dermatitis. Whereas, formerly this condition appeared in from three to five weeks, varying with the resistance of the individual case, it is now possible to keep up the x-ray exposures indefinitely in most cases. The x-ray diminishes the resistance of the skin, and light increases it. If, therefore, it is desirable to produce a profound effect of the x-rays upon tissues beneath the integument, the employment of the arc light of sufficient intensity, projected against the surface, will restore the resistance of the skin, without diminishing the effects of the ray upon parts beneath.

"It is customary to employ an arc of sufficient intensity to produce heat which can be just tolerated over a circle fifteen to twenty inches in diameter, when the patient is placed ten feet from the apparatus, i.e., with parallel rays thrown against the surface. The use of the arc light is usually begun after exposures to the x-ray have been made on alternate days for

about two weeks, and persisted in during the course of treatment to be administered for ten to fifteen minutes following each application. Under this régime it is possible to keep up practically continuous application of the x-ray without the induction of dermatitis; or, if dermatitis occurs, the skin may be restored to a normal condition in the shortest possible time by this method of treatment. For obvious reasons, the arc light is not employed over superficial or open processes. It is hardly necessary to add that whenever a dermatitis does occur, even as it may occasionally, during its employment combined with the light, x-ray exposures should be discontinued, and the use of the light persisted in.

"The employment of the arc light in the above manner adds to the possibility of success in the treatment of deep-seated conditions.*

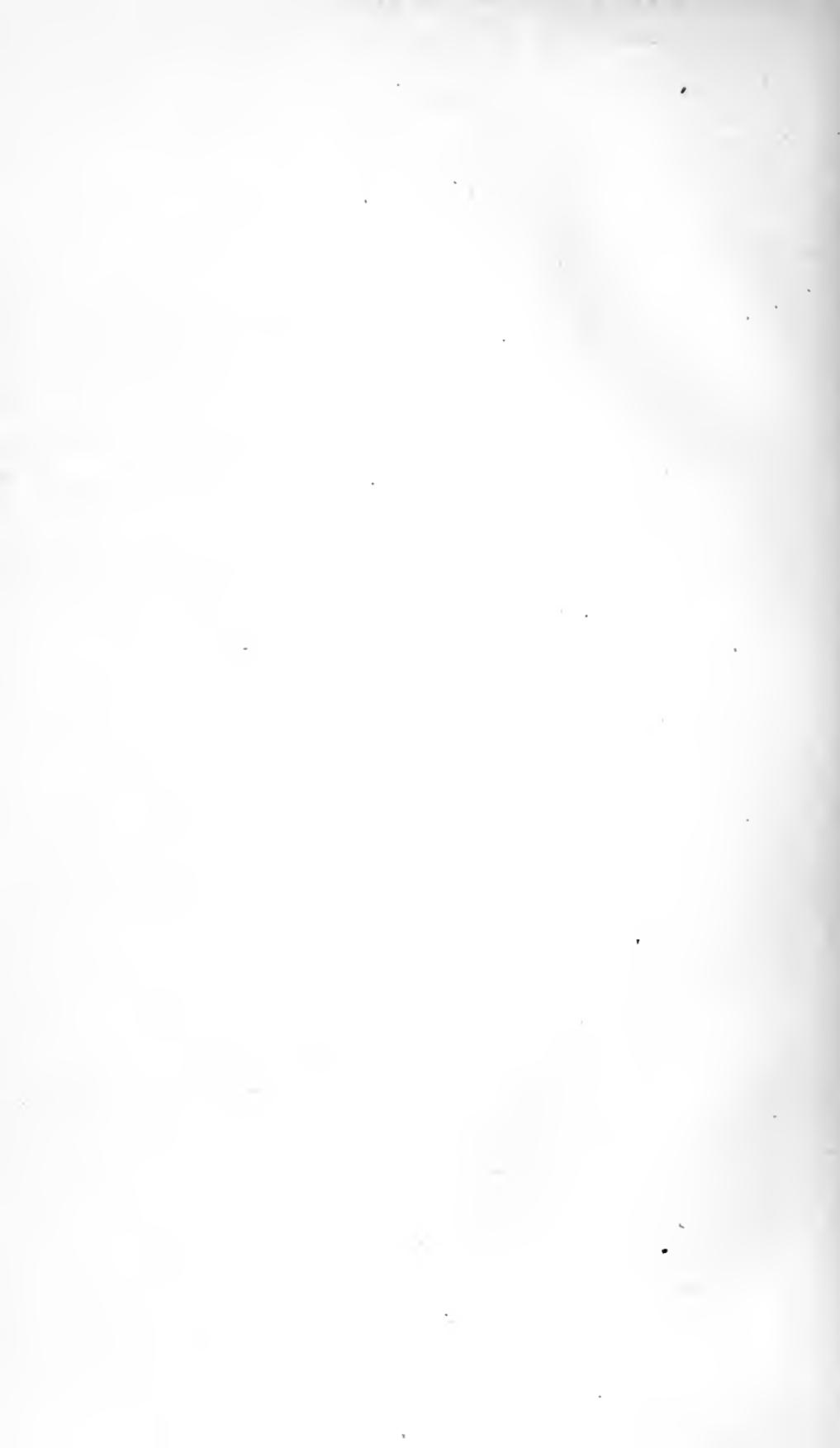
It will be observed therefore from the foregoing observations and experiments that the effects of radiant light and heat are diametrically opposite to each other. In other words, one is the exact antithesis to the other—the former producing direct stimulation and increased metabolism and nutrition, while the other, carried to the physiological degree, induces distinct inhibition and diminished metabolism, terminating in a degree of tissue inertia which will result in the death of the tissues irradiated if carried too far.

The high-frequency currents, static-brush discharge and other stimulating electrical discharges, are analogous in other effects to radiant light and heat, and offset in a similar manner the inhibitive effects of the Roentgen ray. Failure to recognize this fact has led to incorrect observations with reference to the Roentgen ray as applied with the tube in contact with the tissues; one writer having misconstrued the fact that with the x-rays administered in this way, a mixed effect is derived from the high-frequency discharges from the surface to the tube when so applied; for which reason much longer exposures are required to produce the peculiar effects of the x-ray resulting in a final dermatitis. A dermatitis will occur, however, from x-rays applied in this manner, as has been demonstrated in the experience of several observers, indicating that the

* "The Employment of the Arc Light as a Prevention to X-ray Dermatitis in the Treatment of Deep-seated Conditions," JOURNAL OF ADVANCED THERAPEUTICS, December, 1904.

Roentgen ray administered for the same length of time with the mixed high-frequency discharges, has a dominant effect. From this fact it will be generally acknowledged that it is better to employ an agent strong enough to induce an inhibition first, and when signs of dermatitis appear, to then institute the use of light or the high-frequency currents to offset or restore a degree of tone to the tissues, which will prevent an unpleasant degree of x-ray dermatitis. The writer has used the x-ray and the other forms of radiant energy in this manner and has demonstrated all these relative effects for the past five years. Without exception, the dermatitis produced by the Roentgen ray has been readily counteracted by the subsequent application of radiant light, or the static brush-discharge or the high-frequency currents to a surface so affected.

SECTION II
CONVECTIVE HEAT



CHAPTER I

COMPARISON OF CONVECTIVE HEAT AND RADIANT HEAT

Convective heat, in contradistinction to *radiant heat*, possesses the advantage of being a convenient means for domestic and professional administration under conditions in which the combined heat and light radiations from the sun, or the electrical incandescent or arc light, are not accessible nor convenient, and may be preferred in certain cases. The physical difference between these two methods of heat administration for therapeutic purposes is at once suggested by the distinction between radiation and convection.

Radiant energy projected against the tissues, penetrates to considerable depth as the radiant heat energy moving with great rapidity impinges upon the tissues of the body. Administered from radiant sources, the action is not to the same extent limited to the circulating fluids of the body, but acts upon all other structures upon which the radiations impinge and to a greater depth; including all cells of the muscular, nervous, and connective tissue structures; thereby carrying into the tissues degrees of heat, which are not rapidly dispersed by convection, and raising and maintaining the temperature of the tissues to a higher degree than with the convective methods of administration; the influence of which, applied to the surface of the body, does not permit the penetration of the heat to any considerable depth as has been well shown by Gilman Thompson and others. By the convective methods, the blood becoming heated is rapidly conveyed onward, raising the temperature of the body, but resulting under normal conditions, in the induction of intense hyperemia and perspiration, followed by evaporation with the secondary cooling effect of latent heat absorption, thereby maintaining normal blood temperature throughout the body. Another advantage is also conserved—the elimination of effete material through the activity of the sweat glands. The areas immediately contiguous to the application of convective heat, become at first hyperemic through the stimulating effect of the application, thereby permitting a larger volume of the blood

stream to become heated and coincidentally other actions take place within the tissues in the vicinity, the importance of which will be subsequently considered.

In the application of convective heat, *moist* and *dry*, the following methods are employed:

The application of dry heat to the surface of the body may be made with temperatures ranging from 150° to 200° F., tolerated without covering. It is readily apparent that dry heat possesses certain distinct advantages in cases demanding a marked degree of general peripheral stimulation, and coincidentally in a dry air a rapid absorption of heat by the prompt evaporation of perspiration takes place, thereby facilitating profuse elimination of effete and toxic materials and inducing a marked degree of end nerve stimulation followed by prompt responses of the vascular and respiratory centers. *Moist heat* applications do not permit of local evaporation, though the heating of the blood does induce perspiration to a degree from the surface of the body not exposed to the direct application of the moist heat. These distinctions render the two forms of convective heat application of distinct advantage or disadvantage according to the condition for which it is employed.

The means of applying moist heat have been long in vogue and comprise the employment of poultices, a combination of kaolin and glycerine, or the familiar antiphlogistine administrations, as well as the use of douches, and the general application of steam or Russian baths. *Moist applications* may also be applied by placing a damp flannel cloth over the surface treated, over which dry heat should be applied from hot flannel pads, hot water bags, or other heated material.

The method of using moist heat may be by application of local poultices, hot water bags, pads or other heated materials placed over moistened flannels, or the employment of kaolin cataplasms, or antiphlogistine, heated as hot as can be borne, the heat being maintained in all cases by frequent changes of the poultice or overlying material which gives up its heat least rapidly, as water in bags, or heated flannels, or heated objects wrapped in flannel. Another well recognized method of applying heat to the cavities of the body is by means of hot water douches or enemas. For *general* applications of moist heat, the hot bath or Turkish or steam baths are the means usually employed.

CHAPTER II

PHYSIOLOGICAL EFFECTS OF CONVECTIVE HEAT

The physiological effects of convective heat give it rank among the most valuable of the therapeutic agents. It occupies a well recognized place of great utility in the sanitaria, at the bedside, and in the office of the practitioner. The effects may be divided into local and general.

The local applications of convective heat as applied to inflammatory conditions, from the point of view of a local constringent, was ably described by Dr. Thomas Addis Emmett in the third edition of his work on "Principles and Practice of Gynecology," page 111, in the following language:

"Cold is a prompt exciter of reflex action by which the vessels are made to contract, but on reaction taking place, the parts will become more congested than before, both the arteries and the veins being distended.

"Heat, unless at a temperature that would destroy the parts, does not act so promptly in causing this contraction as either electricity or cold. In fact, its immediate effect is to cause relaxation, and to increase the congestion of the parts; but, if its application is prolonged reaction ensues, and contraction takes place; in other words, the reaction from heat is contraction. Under the increased nerve stimulus the capillaries are excited to contract, this effect extending also to the coats of the larger vessels, and as their caliber becomes smaller the congestion is diminished. The popular belief is that heat relaxes and increases the congestion of parts, and such indeed is the case at first. But a hot poultice is never applied with the object of increasing the congestion, but, as any 'old wife' would express it, to draw the 'fire' or inflammation out; in other words, it lessens the congestion by stimulating the blood-vessels to contract. That such is the effect, from the prolonged use of a poultice, is familiar to everyone, and is well shown by the blanched and shriveled appearance of the tissues after its removal. The hands and arms of a washerwoman, when in hot water, become swollen at first, from the increased

flow of blood to them, but it is a well-known fact that they afterwards become markedly shriveled.

"Placing the hands in cold water at once causes the skin to shrivel, as the vessels are stimulated to contract, but we know that reaction promptly comes on, and a larger quantity of blood returns to the parts than was driven out. But, after soaking in hot water, the skin does not recover its natural appearance for hours, since the capillaries remain contracted. In their return to the natural state the reaction does not go on to a paralysis of over-distention, and hence there is no subsequent congestion. The immediate effect of cold upon the capillaries, therefore, is contraction, and with reaction comes dilatation; but the reverse is true of heat, which causes at first dilatation, followed by contraction."

Acting upon the principles laid down in the above explanation of the effects of heat and cold, the author has made use of these agents for more than twenty years. At the time of the publication of the third edition of Dr. Emmett's work (1884), there was no published knowledge of the action of the phagocytes—connective tissue cells (macrophages), or leucocytes (microphages)—which envelop germs and devour them. The significance, therefore, of the induction of intense local hyperemia and the fact that such hyperemia favored destruction of microbes, could not then be appreciated. At this time, however, when it is a well established fact that the body in varying degrees depending upon the physical condition of the individual is capable by its own defenses of destroying infectious elements through the agency of these active cell bodies, the recognition of phagocytosis is of the greatest significance.

That in the early stage of superficial suppurating processes, the application of heat, with the proper degree of energy, is a most certain means of resolving the process, has been established by the writer and many other observers by practical experience.

There are several possible factors which may be active in effecting the resolution and healing of septic processes as induced by the administration of hot applications. (1) The increased hyperemia occurring with tissue relaxation, which is present during the early part of the heat administration, brings into the involved tissues a greater number of leucocytes

in proportion as the volume of arterial blood is increased, together with an increased amount of oxygen, so essential to local metabolism and prompt diapedesis of the leucocytes. (2) The profuse local and general perspiration induced, alters toward normal the fluids in the field of involvement and coincidentally eliminates to an extent other materials affecting the constitutional condition of the patient possibly favoring a general phagocytosis. (3) The action of heat, upon the superficial tissues, may coincidentally inhibit the activity of the microbes, or by altering the constitution of the fluids, as suggested, produce a larger degree of positive chemotaxis. (4) The production of more active metabolism in the tissues will tend also to increase the natural fortifications of the involved tissues, increasing the activity of the macrophages.

Clinical experience has well demonstrated the efficacy of the hyperemia and stimulating effects of heat in effecting the local destruction of infection—a fact worthy of investigation and definite determination as to whether in the workings of the *vis medicatrix naturæ* the fever process is not a condition created for action unfavorable to the infecting microbes, by coincidentally favoring a positive chemotaxis or action tending to limit the disease. The remarkable effects derived from administrations of dry hot air in the destruction of local and general infection with the coincident falling of the body temperature to normal, would seem to indicate that the workings of nature's processes against infection are normally, by raising the body temperature to assist the phagocytes, to destroy the microbes by the induction of such increased body temperature—the fever. If so, it is evidently an error, except under conditions of extreme hyperpyrexia, to interfere with body temperature, and rather than employ cold baths, to institute the use of the body dry hot air or light baths to assist nature, in increasing the activity of the phagocytes.

The following observations made by the writer, with Drs. Grad and Munday, would seem to fortify this hypothesis. A patient *in extremis* from general septicemia, three weeks after a difficult surgical operation, with the characteristic feeble pulse, livid countenance, and a temperature of 105° F., was wrapped by the usual method in Turkish toweling and placed in a body hot air apparatus at a temperature of 300° to 350° F., and after thirty minutes removed with a full strong pulse,

a marked hyperemia of the skin, and a mouth temperature of 103° F. Eight hours later the temperature was normal, and the patient convalescent in ten days. This extraordinary result could only be explained by (1) the induction of an active phagocytosis with a positive chemotaxis; (2) stimulation by heat of the deep spinal centers, particularly the cardiac and respiratory; and (3) the elimination of toxins and other bodies through the agency of the profuse perspiration induced by the high temperature.

The writer has invariably observed the rapid fall of temperature following the application of heat to areas of local infection as in suppurative tonsilitis, as well, also, in cases in which the static current has been employed for the relief of early local infection.

The action of local dry heat on localized septic infection, when high temperatures are employed, as in the case above described, has been uniformly successful in the writer's experience even in cases of extensive local infection involving the hand and arm and also in cases of gangrene, all tending to confirm the physiological effect of high temperature in relieving local as well as general infection.

In conditions of poor metabolism, arising from bodily inactivity, excesses in diet, and auto-intoxication, the effects of convective dry heat or the combination of radiant light and heat together with convective heat, as administered in inclosures with the high candle-power incandescent or arc lights, or better in the incandescent electric light bath, are remarkably efficient in promoting the elimination of waste products through the skin, and coincidently by stimulation of the deep spinal centers, the effect of exposure of the surface to intense heat thereby inducing greater activity of the other channels of excretion and elimination. This fact is clinically well demonstrated by chemical analysis of the secretions and relief from conditions of auto-intoxication, nephritis, and gouty and rheumatic affections. It is an undoubted fact that owing to effects of profuse perspiration, the sweat glands do eliminate nitrogenous, toxic, and other effete materials from the organism, which in nephritis is wonderfully effective in relieving the labor of the diseased kidneys, and removing the danger from other grave conditions.

The action of dry heat in the body apparatus upon the

EFFECTS OF CONVECTIVE HEAT

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periphery induces a pronounced general hyperemia of the skin, and coincidently stimulates the activity of the heart and respiratory centers. Together, however, with the profuse perspiration, the draft upon the general circulation to the hyperemia of the skin, offers the only danger from the administration by leaving too small amount of blood in the larger arteries. Such danger is obviated by keeping the patient in a recumbent position and administering frequent draughts of water during and following the administration.

CHAPTER III

ADMINISTRATION OF DRY AND MOIST HEAT

The administrations of dry heat are best executed locally by means of the hot water bag wrapped in dry flannel cloths to prevent the too rapid escape of heat, or by means of the various dry hot air apparatus manufactured for local and general treatment, by the application of other heated substances to the surface, or by the use of Turkish baths. *The application of dry hot air* by means of the hot air apparatus, the body being wrapped in Turkish toweling, partakes to a slight degree of the character of moist applications, the perspiration constantly escaping from the body to be absorbed by the Turkish toweling, but to no extent approaching the degree of moisture of the wet applications.

The methods of applying moist heat are in principle the same; the object being to maintain a temperature as high as can be borne on the surface of the body or in the cavities for periods of time, varying with the indication for relief of the affection under treatment.

The poultice, the oldest popular form of heat application, derives its efficacy from the length of time which it will maintain a higher temperature than the body. The material best suited for the purpose is therefore one which will hold the heat for the longest time. Flax-seed has generally been the material preferred. The writer recalls the old way in which the poultice was used by the layman and the physician who little appreciated the *requirements* of the poultice. A thin paste applied hot, as if the virtue lay in the paste, but not changed for hours, or a day, was too often the error of our ancestors and their patients. By these it was little realized that the object of the poultice was the application and maintenance of intense heat for its therapeutic properties.

Time has practically displaced the poultice as the institution of the hot water bags and the later preparations of *kaolin* cataplasms of which the proprietary preparation, *antiphlogistine*, was the earliest if not the best product of the kind. It

possesses such advantages over the sodden poultice that the latter is employed relatively little by the present generation. In his own private practice the writer, before the days of antiphlogistine and before the general use of the water bag, recognizing the principles of heat application, instituted for his own cases the employment of large, thick, woolen pads, made of old material quilted together in pads of one and one-half to two inches in thickness, and of sizes large and small to meet varying conditions, two of them being always in requisition. It was the custom to apply the heat in this manner by placing one thickness of flannel cloth wrung from hot water over the inflamed area, following, usually, the application of a sinapism, alternating the application of these two pads every fifteen or twenty minutes, thereby maintaining for hours an intense application of moist heat, the changes being effected without exposing the surface to the cool air of the room.

The hot water bag may be employed in the same manner, but its weight is often objectionable. When used, if wrapped in flannel, the heat is preserved for a longer time. When of the proper size, if the water is frequently changed, it is a convenient and practical means of maintaining heat application.

In *antiphlogistine*, the proprietary preparation, or the kaolin cataplasm, is added the hygroscopic glycerine which is capable of abstracting considerable fluid from the tissues—another advantage particularly in inflammatory conditions associated with infiltration. When this or similar preparations are used they should be applied in a thick coating and as hot as can be borne directly to the bare skin. It is desirable in most cases to maintain the heat in these materials by the application of dry heat over all, as of the hot water bag, the additional application thereby maintaining the heat as long as is desirable. In these applications the effect is derived from the dry heat and the combined depleting effects of the glycerine in combination with the heat conducting qualities of the material of which they are composed.

The Russian bath is deservedly the least popular of all of the moist applications; because the patient is not only subjected to intense heat in a moist atmosphere, and the necessity of employing lower temperatures because the moisture does not permit of ready evaporation from the surface of the body of perspiration, and at the same time the patient is subjected to

the inhalation of the heated steam. The method is of too little therapeutic value to deserve more than mention of its characteristics. Administrations of convective dry heat in a hot box or the Turkish bath in such a manner that the perspiration will be rapidly evaporated, are far superior in their effects to the use of the moist steam bath.

The hot water bath as a general application possesses an advantage over the Russian bath and is a convenient method of inducing prompt relaxation or reflex stimulation under conditions in which it would not be convenient to administer the Turkish or dry hot air bath.

The hot douche for the employment of heat by means of hot water, is the recognized method of administering heat to the cavities of the body. The method was first accorded urgent recommendation by Dr. Thomas Addis Emmett, of New York. The value of this measure is appreciated by the profession at large; but too often douches have been administered in a perfunctory manner, the necessity for maintaining the temperature at 108° to 110° F. for long enough periods of time not having been generally appreciated by many who have employed and prescribed it. The value of this method was ably described in the work of Dr. Emmett.

The administration of dry heat may be made either by means of apparatus constructed for the purpose as the local and body hot air apparatus, or by means of light baths which combine the effects of radiant and convective heat; the accumulated heat in the inclosed cabinet having the convective characteristic with the radiant heat added.

Another method which is practical at the bedside is effected by placing alongside of the patient, covered with one thickness of Turkish toweling to prevent the bottles of hot water from coming in contact with the skin, or by wrapping the receptacles in moist or dry flannel cloths, as many gallons of boiling hot water as is desirable, covering all with flannel blankets. In this manner dry heat may be applied with pronounced effect at a temperature of approximately 200° F. and maintained for as long a time as desirable.

When the local or body hot air apparatus is employed, the parts exposed to the heat should be wrapped in two or three layers of Turkish toweling so applied as to come in contact with every part of the surface so exposed, in order that the



Plate VII.—Local Betz Knee Joint Apparatus as Applied.

perspiration as it escapes from the tissues may be taken up by capillary attraction from the surface by the little wicks of the toweling. At any part of the surface that is not in contact, drops of water will collect, boil, and scald the surface; for with the temperatures employed, 300° to 400° F., the water will be readily raised to 212° by the penetration of heat through the wrappings. The rapid evaporation from the skin under these conditions permits an intense application of heat to the surface under the above precautions, with the induction of intense hyperemia and without danger to the tissue so exposed, offering one of the best facilities for the induction of profound reflex stimulation and intense hyperemia so valuable for the treatment of infectious troubles, as well as inducing pronounced elimination through the agency of the perspiration.

The hot box, used in connection with hydrotherapeutic applications, is so constructed that the patient, seated upon a stool, nude, with the head protruding through an opening, which closes about the neck, is exposed to an influx of dry heat at temperatures from 200° to 225° F. This method is so employed, when it is intended to be followed by the application of the hydrotherapeutic douche, spray, or plunge, the sudden changes of temperature being employed to induce extreme degrees of reaction. *The light bath*, as employed by Winternitz and his followers in connection with the hydrotherapeutic establishments, is rapidly replacing the hot box.

The Turkish bath administered to the patient nude in a room heated to a temperature of from 150° to 170° F., is a popular method of applying heat for the induction of perspiration. The particular objections to this method are that the patient is obliged to inhale this heated air, and that with the head in the same temperature, moist towels but partially relieve the disagreeable effects of cerebral congestion. This method of treatment is as a rule employed in connection with rubbing, kneading, and massage, and possesses certain advantages of a popular sort, but is not calculated for use in the treatment of localized conditions, or when there is indication for profound effects upon general metabolism.

CHAPTER IV

THERAPEUTICS OF CONVECTIVE HEAT

The *indications* for the employment of convective heat suggested by the physiological effects upon the organism, comprise its application alone or in conjunction with radiant light and heat, the x-ray, or the static or high frequency currents, one or more of them, in the treatment of infectious inflammation, and in the early stage of traumatic or non-infected inflammation, when sometimes better means are not at hand. It is also a valuable factor in association with other measures applied with the body hot air apparatus or light bath for the relief of defective metabolism.

The *therapeutics of convective moist and dry heat* at the bedside and in many conditions in which other measures better adapted are not at hand, is very large and under these conditions is one of the most valuable means at command.

The *local use of convective heat* is indicated in all superficial inflammatory processes associated with the presence of pus; not in a perfunctory way by the casual application of a hot wet poultice, a hot water bag, or a thick layer of antiphlogistine to be left *in situ* for hours without the application of additional heat, but with strict observance of the temperatures employed and of the time necessary to meet the indication.

The *treatment of an early quinsy or suppurative tonsilitis* which may be readily aborted if given proper attention, would go on suppurating with the indifferent use of local heat applications. In tonsilitis some application may be made first as a sinapism for the purpose of inducing a very active local hyperemia, over and around the indurated area, to be removed before blistering as soon as an intense redness is effected. A thin flannel cloth, large enough to cover the spot rendered hyperemic by the mustard, wrung from hot water should be laid over the surface, and over this a large hot water bag covered with several thicknesses of flannel or a pad made of several thicknesses of flannel should be placed. The hot water bag or heated flannel pads used should be changed as often as necessary to keep the heat at as high and

uniform temperature as can be borne. These applications should be maintained for four or five hours, or until every bit of induration or pain has disappeared. If such applications are made on the first or second day, the effect is abortive and, as suggested above, is explained by the fact that the hyperemia is effected with coincident relaxation of the involved tissues, associated with the presence of a greater number and greater activity of the phagocytes—conditions favorable to the destruction of the germs, followed by the later constringent effect with final resolution of the induration, and removal of every trace of the inflammatory process.

The same effect as in tonsilitis is readily obtained in the treatment of *felons* or *whitlows*, by another method. With a cup of water and a pitcher of boiling water at hand, the patient is directed to at first place his finger, out and in, the fluid in the cup until it can be held constantly within the hot water, adding from the pitcher of boiling water from time to time sufficient to maintain the highest possible temperature that can be borne. It is important to keep this up from three to four hours, or until all pain has ceased, and the finger is in a shriveled and puckered condition, repeating the procedure after several hours, if necessary, until no pain returns. In the early stage when the throbbing and pain are well established, but before much pus is present, this method will invariably abort this painful condition. The same result can be effected with the static brush discharge or the vacuum tube current taken directly from the static machine in from ten to fifteen minutes, and likewise in tonsilitis. (See Snow's "High Potential Currents.")

In the early stage of mastoiditis, or of furuncles in the aural canal, or otitis media, the surface application of heat in the same manner as in the treatment of tonsilitis and for as long or longer periods of time, when employed early, is very effective in relieving the conditions, though not with such energy and promptness as the application of radiant heat. The same method is applicable to the treatment of boils, furuncles, and other abscesses superficially located.

In inflammatory conditions of the pleural and abdominal cavities, applications of heat on the same principle are very effective, though in deep-seated conditions they will often utterly fail of effecting the desired result.

In pleurisy, treatment for from three to five hours with large surface applications kept as hot as can be borne, a happy result is promptly effected in most cases, and it is a question if many cases of pneumonia may not be aborted by these same early applications of heat in conjunction with other rational procedures. Probably in this case the employment of kaolin cataplasms or antiphlogistine in a thick hot layer placed over the affected area, over which applications of heat are made to maintain the temperature, is a most convenient and effective means of treatment. It is a striking fact that over some conditions, these preparations, mixed as they are with glycerine, will become dry and hardened, while in others the abstraction of moisture will cause the composition to become thin and volatile in consistence. This is explained from the fact that in severe inflammatory conditions of congestion with impaired secretion, the tissues seem to absorb the glycerine from the compound.

In peritonitis and the painful conditions associated with *appendicitis* or other abdominal abscesses, where the weight of the application is an objectionable feature, the application of a sinapsism, followed by the flannel cloth wrung from hot water, and the subsequent frequent changing of heated flannel pads, for hours, maintaining as high a temperature as can be tolerated, is indicated. This method first favors a localized active phagocytosis, and is later followed by a resolvent action and restoration in favorable cases as a result of the destruction of the germ *in situ*.

Applied for relief of the deeper processes, as demonstrated by Gilman Thompson,* the effects of convective heat are not effective. Hence the administration of convective dry heat is generally ineffective, except in so far as it raises the general resistance by promoting metabolism and general elimination. In such cases, however, the body hot air bath, by employing very high temperatures, offers much; but probably no agent, except the x-ray, which has a potent effect upon pus processes, is more efficacious in deep-seated processes than radiant light and heat focused to small surfaces or applied largely from sources of high candle-power. There is no doubt in the mind of the writer, from his own experience, and the experience of his *confrères*, that radiant light and heat are very effective in influencing deep inflammatory processes in the

* Thermotherapy, New York Medical Record, April, 1907.

cavities of the trunk, and are indicated in all such cases, the applications being made for considerable time, and as close to the source of radiation as can be borne, and frequently repeated until the inflammatory process is abated.

The employment with the local hot air apparatus over inflammatory regions in the pleural and abdominal cavities, is another efficient method of applying convective heat in these cases. The patient, reclining, is placed near the edge of the bed, with the side or surface involved directed towards the open side of the apparatus. The surface to be treated is then wrapped with two or three layers of Turkish toweling and the hood of the apparatus is brought to the surface in such a manner as to convey the heat to the affected area; by this means temperatures ranging from 300° to 400° F. may be administered for as long a period as indicated, usually for from twenty minutes to one-half hour.

Another method of employing convective dry heat in connection with cold applications will prove invaluable in some subacute inflammatory processes, or abdominal hyperemia, as follows. In congestion of the large glands, the liver and spleen, for example, associated with a low grade general metabolism, the application of heat to the lower portion of the trunk and limbs, by means of several gallons of boiling hot water in receptacles, wrapped in flannel cloths and placed upon the blankets upon which the patient reclines, and then with all the lower abdomen and lower extremities enveloped in blankets, cold compresses at a temperature of 60° F., and frequently changed are applied over the involved glands. This method will be found also invaluable in cases of reversed peristalsis, when occurring in connection with post-operative vomiting. The happiest result in a condition of this kind was effected in the writer's family at the suggestion of Dr. Morris W. Brinkmann, of New York, and its value, well attested by the prompt relief afforded after three days of stercoraceous vomiting.

*The use of hot douches for rectal and colonic flushings, and the treatment of pelvic cellulitis *per vaginam*, which is cordially recommended as instituted by Dr. Thomas Addis Emmett,* is a means of conveying convective heat into the cavities of the body, which has proved extremely efficient in the class of cases*

* *Principles and Practice of Gynecology, 3d edition, page 113.*

in which it is indicated. The correctness of the technique employed in these cases is of the utmost importance. It should be borne in mind (1) that the treatment is for the purpose of the convective application of moist heat to inflammatory conditions; (2) that a temperature should be maintained at as high a degree as can be tolerated (from 108° to 115° F.); (3) that it should be administered to the patient with the hips elevated, with the employment of a proper douche pan; and (4) that the flow should be retarded and the time of the administration be made from thirty minutes to one hour, the quantity of water employed being the secondary consideration, the *time element* and *temperature* being the elements of greatest importance. In congestion associated with infection, a hot douche will prove of the greatest service at the bedside, but will not compare in value with the employment of the static and high frequency currents in inflammatory conditions, using the static wave current or the direct vacuum tube current in non-infected cases, or the high frequency currents or the x-ray in infected cases.

In cases of general septic infection following a condition of localized infection, the employment of the body hot air applications at temperatures varying from 250° to 350° F., the patient properly wrapped in Turkish toweling, as previously described, offers, we believe, one of the greatest possibilities of controlling those generally fatal conditions of any means yet employed. The light bath employing the combined effects of radiant light and convective heat, from accumulation of heat, in the cabinet, may serve an equal or better purpose in such cases, in accordance with the physiological effects upon phagocytosis and active elimination and stimulation of the reflex centers, all of which tend to raise the opsonic index and increase of the body energy.

The treatment of localized septicemia in the extremities offers an efficient means; and a greater boon to humanity, is hard to find than the employment of convective dry heat in these cases, with the proper local apparatus capable of employing temperatures of 200° to 400° F. In these cases it is always necessary to open up and drain all collections of pus, when the subsequent daily applications of dry heat in the manner described will effectually terminate the infectious process in all cases within a few days, three usually sufficing.



Plate VIII.—Treatment of Leg and Thigh with Local Betz Dry Hot Air Apparatus.

In cases of remote acute congestion, as in lesions of the spinal cord, or liver, it may be desirable to stimulate the vascularization of the skin in order to drive as much as possible of the blood from the deep processes into the skin. In these cases, the employment of the body hot air bath, or at the bedside by placing many gallons of hot water in receptacles wrapped in flannel cloths about the patient in bed and over all placing several blankets, is effective. By this means a temperature of 200° may be maintained for the desired length of time, varying with the conditions under treatment.

The treatment of non-infectious inflammatory conditions, by the employment of convective moist or dry heat, is of comparatively little efficiency except in the early stages of such congestion. While it may relieve pain temporarily by lessening tissue and vascular tension, it will fail to remove the existing condition of *stasis* with the associated tissue infiltration and induration, and consequently fail to effect complete relief of the condition. This has been amply demonstrated in the treatment of synovitis, sprains, and contusions which promptly yield to the administration of the static current. When these means, however, are not at hand, in the early stage of trauma, the judicious employment of heat, preferably dry heat, in connection with strapping, is often effective, but not so promptly as applications of static currents and sparks.

For defective general metabolism associated with gout, rheumatism, and auto-intoxication—the forerunners of arteriosclerosis,—the frequent administration of convective dry heat or radiant and convective light and heat administrations in the light bath, are measures demanding the most urgent recommendation; for by acting reflexly upon the centers governing the functions of excretion and elimination of the skin, kidneys, and other emunctories, they exercise a most valuable influence in quickening metabolism and promoting an elimination of waste products and toxins from the body, and together with regulated exercise and diet, and avoidance of such things as aggravate the conditions, influence a restoration of the normal physical conditions of metabolism to a degree readily appreciated. Administrations are to be made during the course of treatment, two or three times weekly, for two or three months, or until the conditions of arterial tension and the character of the secretions eliminated, indicate a restoration to

normal of the functions generally. Convective dry heat, or radiant light and heat, always administered in conjunction with auto-condensation, alternated with the constitutional administration of the static wave current, is remarkably efficacious in lowering high arterial tension, and preventing farther destructive or calcareous changes in the muscular coats of the arterioles, thereby warding off or preventing a dangerous degree of arteriosclerosis.

The above observations are readily appreciated by those who have become familiar with the employment of physical agents, but as will be suggested throughout this series, it is evident to the trained medical mind that the greatest results in therapeutics are to be obtained not from the employment of any one physical agent, but by the intelligent employment of each, in combination with others, as indicated to best meet the conditions presenting.

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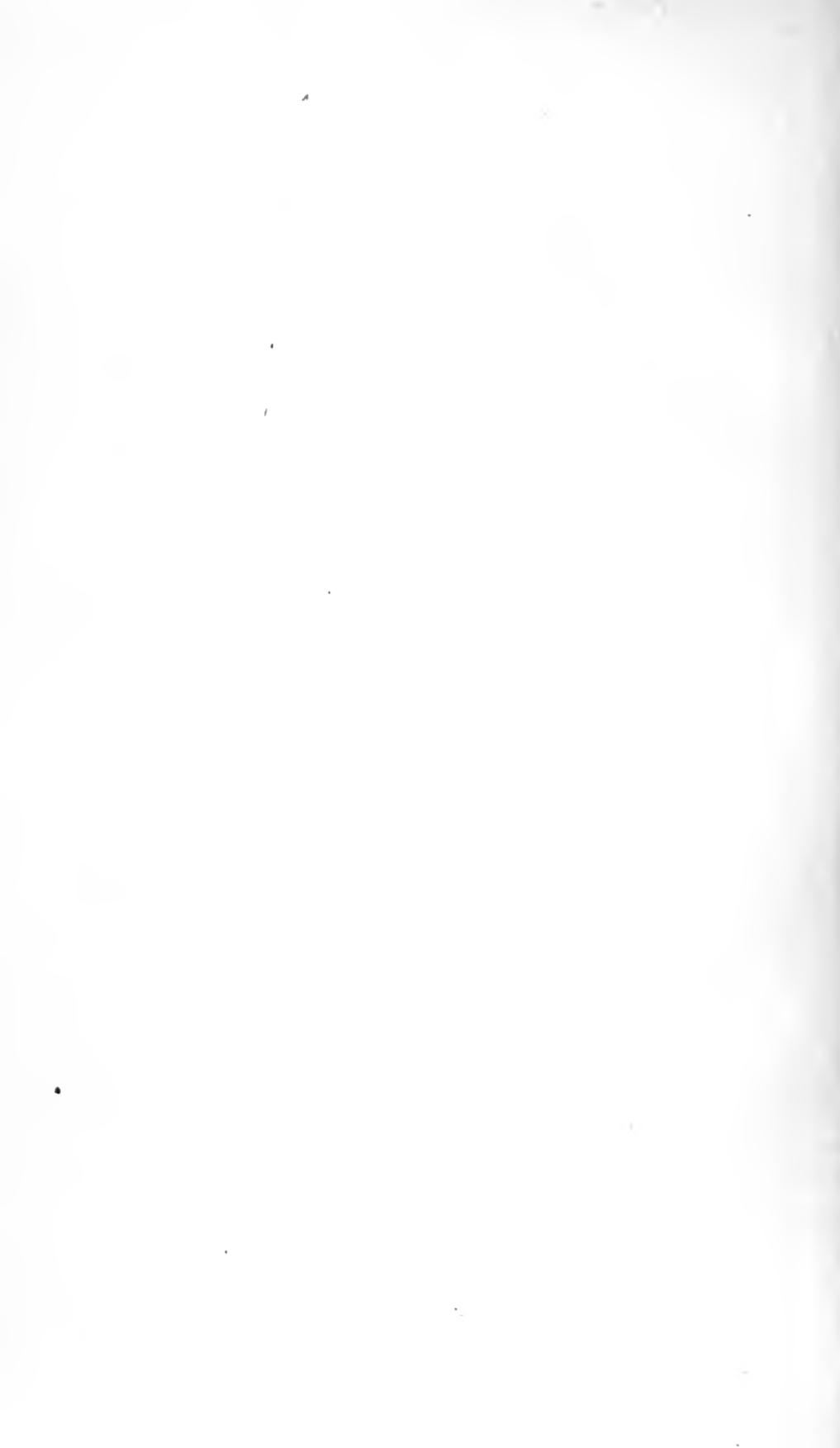
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